Soil Survey of

ADAIR COUNTY, IOWA

United States Department of Agriculture,
Soil Conservation Service
In cooperation with
Iowa Agriculture and Home Economics Experiment Station
Cooperative Extension Service, Iowa State University
Department of Soil Conservation,
State of Iowa

HOW TO USE

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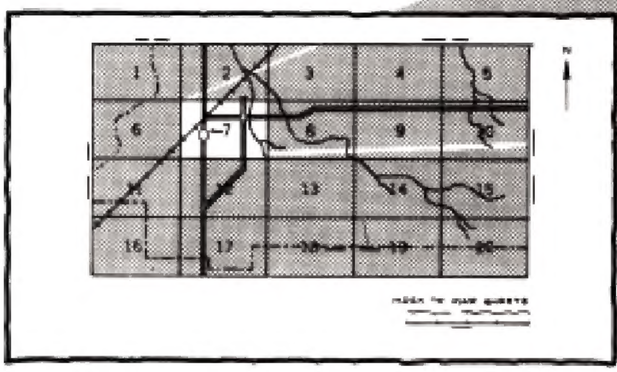

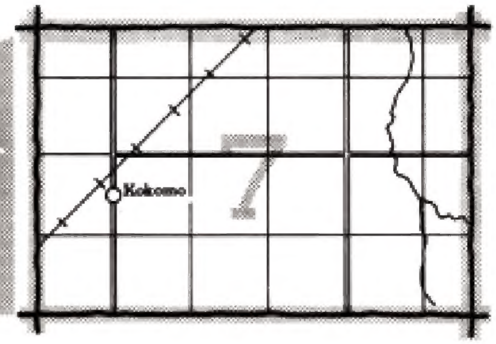

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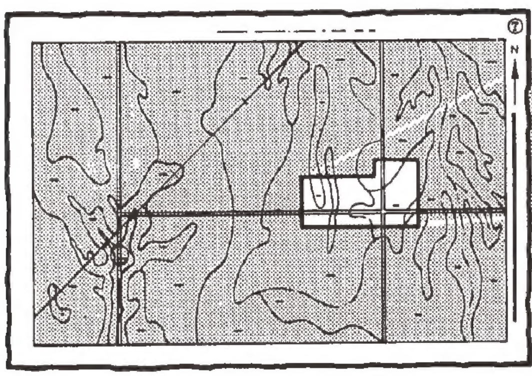

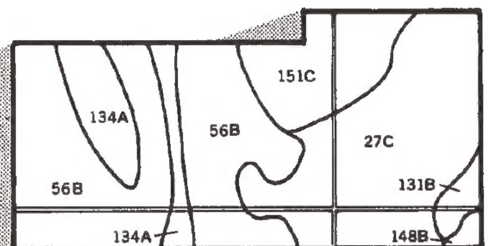

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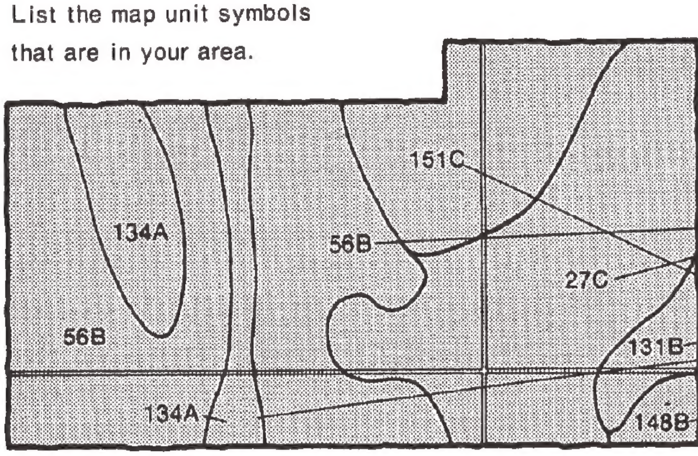

Symbols

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131B
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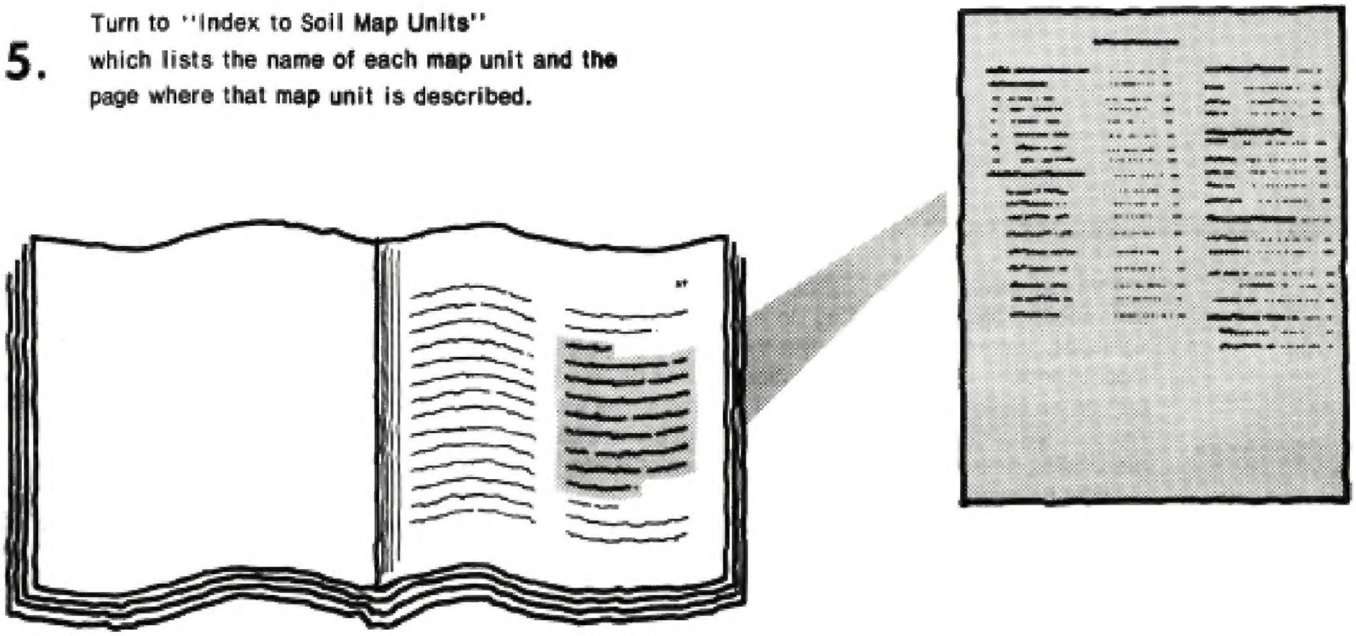
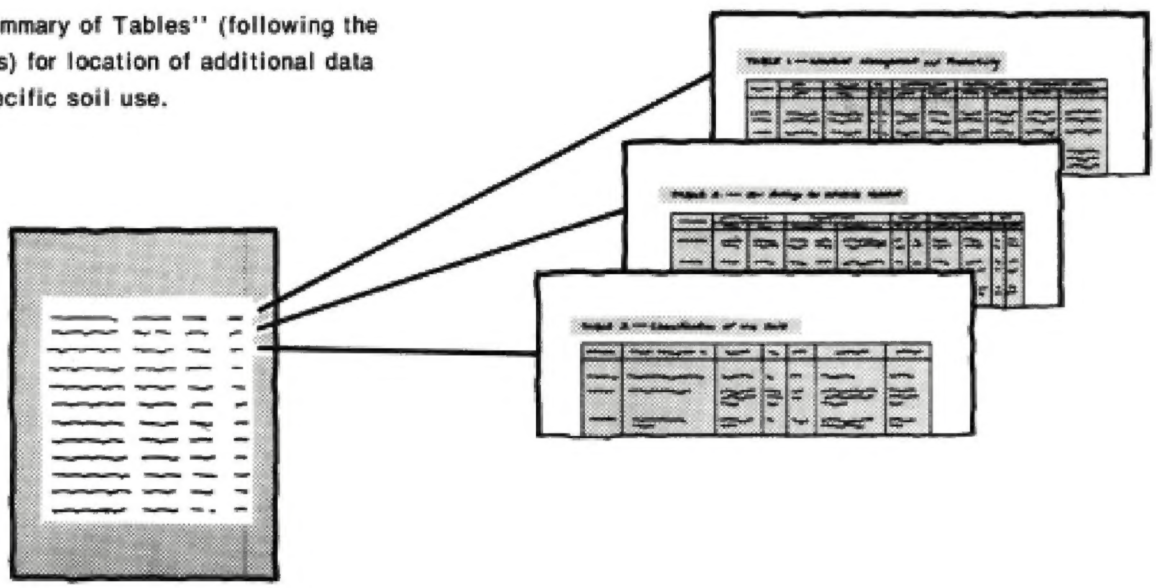
THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1970 to 1974. Soil names and descriptions were approved in 1976. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1974. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Adair County Soil and Water Conservation District. Funds appropriated by Adair County were used to cover part of the cost of this survey.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Contour stripcropping on Gara and Armstrong loams on uplands.

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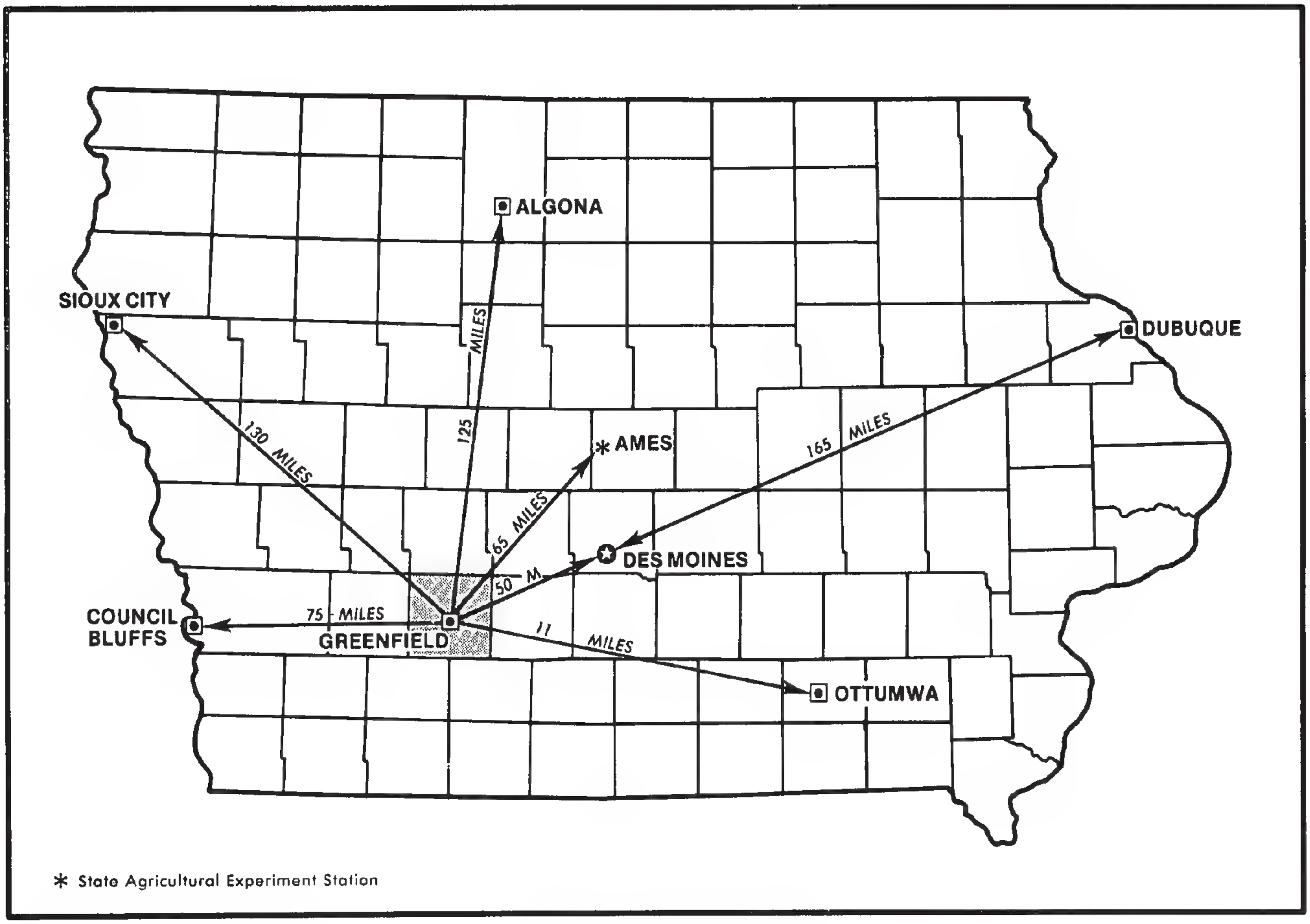
Preface

This soil survey contains much information useful in land-planning programs in Adair County, Iowa. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.



Location of Adair County in Iowa.

Soil Survey of Adair County, Iowa

By Max A. Sherwood, Soil Conservation Service

Fieldwork by Max A. Sherwood, Brian C. Peterson, Louis E. Boeckman, Robert L. Warren, and Randy Rabe, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
In cooperation with
Iowa Agriculture and Home Economics Experiment Station
Cooperative Extension Service, Iowa State University
Department of Soil Conservation,
State of Iowa

ADAIR COUNTY is in the southwestern part of Iowa. The total land area is 573 square miles, or 364,160 acres. Greenfield, the county seat, is about 50 miles southwest of Des Moines, the state capital, and about 75 miles east of Council Bluffs.

Most of Adair County is farmland. The main crops are corn, soybeans, hay, oats, and pasture grasses. A large amount of the grain and forage crops are grown as feed for the swine, beef, and dairy cattle that are raised in the county.

Most of the soils in Adair County formed under a native vegetation of prairie grasses and have a dark, fertile surface layer. The climate is subhumid and continental. Winters are cold, summers are warm, and the growing season is long enough for the crops commonly grown in the county to mature.

General nature of the county

This section provides general information about the climate, relief and drainage, history, water resources, agriculture, transportation systems, and vegetation of Adair County.

Climate

The winters in Adair County are cold; the summers are hot and have occasional spells of cool temperatures. Precipitation occurs mainly as snowstorms in winter and as showers in warm periods. When warm, moist air moves in from the south, showers commonly are heavy. Total annual rainfall normally is adequate for corn, soybeans, and small grains.

Table 1 provides data on temperature and precipitation in the survey area. This data was recorded at Greenfield, Iowa, in the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on the length of the growing season.

In winter, the average temperature is 24 degrees F, and the average daily minimum is 15 degrees. The lowest temperature on record, -28 degrees, was recorded at Greenfield on January 20, 1963. In summer, the average temperature is 73 degrees, and the average daily maximum is 84 degrees. The highest temperature, 106 degrees, was recorded on July 21, 1974.

Growing degree days, listed in table 1, are equivalent to "heat units." Beginning in spring, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The monthly accumulation of growing degree days is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 24 inches, or 73 percent, usually falls between April and September, the period that includes the growing season for most crops. In 2 years out of 10, rainfall in the April to September period is less than 19 inches. The heaviest 1-day rainfall on record is 6 inches, recorded at Greenfield on September 11, 1972. There are about 50 thunderstorms each year, 25 of which occur in summer.

The average seasonal snowfall is 27 inches. The deepest snow at any one time during the period of record was 60 inches. On the average, 17 days in the

year have at least 1 inch of snow, but this number varies greatly from year to year.

The average relative humidity in midafternoon is 60 percent, and the average humidity at dawn is 80 percent. Humidity is always higher at night. The percentage of possible sunshine is 70 percent in summer and 50 percent in winter. The prevailing winds are from the northwest. The highest average windspeed, 13 miles per hour, occurs in April.

Tornadoes and severe thunderstorms strike occasionally. These storms are local and brief and cause sparse damage in narrow areas. Hailstorms occur at times in warmer periods; their pattern is irregular, and they strike in relatively small areas.

Physiography, relief, and drainage

The highest elevation, 1,415 feet, is in the northwestern part of Adair County. The lowest elevation, 1,188 feet, is in the southwestern part of the county.

The topography ranges from nearly level to very steep. The upland divides are mainly gently sloping or moderately sloping. The side slopes along valleys typically are strongly sloping or moderately steep. Most valleys are nearly level or gently sloping. The foot slopes along the edge of valleys are mainly moderately sloping.

The upland divide that separates the Missouri River Watershed from the Mississippi River Watershed is in Adair County. This divide is in the northwestern part of the county near Adair, Iowa. It extends southeasterly to near Greenfield and Orient, Iowa, and from there into Union County, Iowa.

The northeastern part of Adair County is drained to the east by the Middle River. The southeastern part of the county is drained to the south by the Grand River. The western part is drained to the south by the Nodaway River. The extreme northwestern part of the county is drained to the west by Turkey Creek.

History

The area that is now Adair County was settled in 1849. The county was organized in 1851. It was named in honor of General John Adair, an officer in the War of 1812. The Mormon Trail, which passes through Adair County, was used by early settlers on their way west. In 1873, the Jesse James gang staged the first railroad stickup in the United States near Adair, Iowa.

Water resources

The supply of water for municipal, crop, and livestock use generally is adequate; however, at times it is inadequate in most areas of the county.

On uplands, water moves downward through the loess mantle and is restricted by the underlying glacial till "paleosol," a buried soil. In wet periods, a perched water table develops in the loess above the "paleosol," and water seeps out on hillsides along the loess-till contact line.

In spring, the supply of water from this perched water table commonly is good, but it generally is greatly reduced in summer. The average depth of farm wells is about 30 feet. Water for livestock is mainly supplied by small farm ponds and by creeks or rivers that are in pastureland. In 1975, there were about 1,365 farm ponds in Adair County. The average size of these ponds was 1 to 2 acres; however, the ponds range in size from 1/4 acre to 20 acres.

Greenfield, Iowa gets water from a well that is 3,850 feet deep. The well draws water from the Jordan sandstone layer and makes use of a reverse-osmosis system to remove excess salts from the water.

Farming

In 1967, 351,006 acres in Adair County was in farms (*25*). Of this total, 265,545 acres was used for crops, 63,692 acres was pastureland, 12,000 acres was woodland, 9,767 acres was farmsteads, and 876 acres was small areas of water.

Corn is the main crop in Adair County. In 1975, 98,500 acres in corn was harvested for grain and yielded an average of 65.1 bushels per acre; 8,150 acres in corn was harvested for silage and yielded an average of 11.1 tons per acre. Soybeans is the second most important crop. In 1975, 55,500 acres in soybeans was harvested for grain and yielded an average of 27.7 bushels per acre. In 1975, 23,000 acres in oats yielded an average of 34.9 bushels per acre. In 1975, 44,500 acres was in hay (*25*).

With the exception of some cash-grain farms, most of the farms in Adair County receive about half of their income from crops and about half from livestock. In 1975, 149,800 hogs, 37,800 beef cows, and 16,400 grain-fed cattle were marketed. There were 1,200 milk cows. In 1975, the average number of laying hens in Adair County was 37,000 (*25*). The main markets for the cattle and hogs are in Omaha, Nebraska, and Chicago, Illinois. There are some local markets. Milk and eggs generally are processed outside of Adair County. Corn and soybeans generally are taken to local grain elevators for storage or for market; however, some are stored on the farm for a later market or for use as livestock feed. Silage and hay generally are used as livestock feed on the farm where they are grown.

Since the 1930's, the number of farms in Adair County has steadily decreased, and the average size of farms has increased.

Transportation

There are two railroads in Adair County. All-weather paved roads cross the county from east to west and

from north to south. Interstate Highway 80 crosses the northern part of Adair County.

Vegetation

The native vegetation on uplands in the survey area was prairie grasses, mainly bluestems. Along valleys of the larger creeks and rivers, it was mixed grass and oak-hickory woodlands.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After classifying and naming the soils, the soil scientists drew the boundaries of soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil. Map units are described under "General soil map for broad land-use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their characteristics may be modified during the course of the survey. New interpretations are made for local use, mainly through field observation of different soils in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same soils.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is usable to farmers, woodland managers, engineers, planners, developers and builders, homebuyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows map units that have a distinct pattern of soils, relief, and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscape in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Map unit descriptions

1. Macksburg-Sharpsburg-Winterset

Nearly level to moderately sloping, moderately well drained to poorly drained silty clay loam soils that formed in loess; on uplands.

This map unit consists mainly of soils on broad ridgetops and on the adjacent convex slopes on uplands. It makes up about 6 percent of the county. This unit is about 40 percent Macksburg soils, 23 percent Sharpsburg soils, 12 percent Winterset soils, and 25 percent minor soils (fig. 1).

Macksburg soils are nearly level to gently sloping and are somewhat poorly drained. They are on broad divides. The surface layer typically is black and very dark brown silty clay loam about 20 inches thick. The subsoil is multicolored silty clay loam and extends to a depth of about 5 feet.

Sharpsburg soils are moderately well drained and are on ridges and side slopes in areas where slopes are convex. The surface layer is about 21 inches thick. Typically, it is black silty clay loam in the upper part and black and very dark grayish brown silty clay loam in the

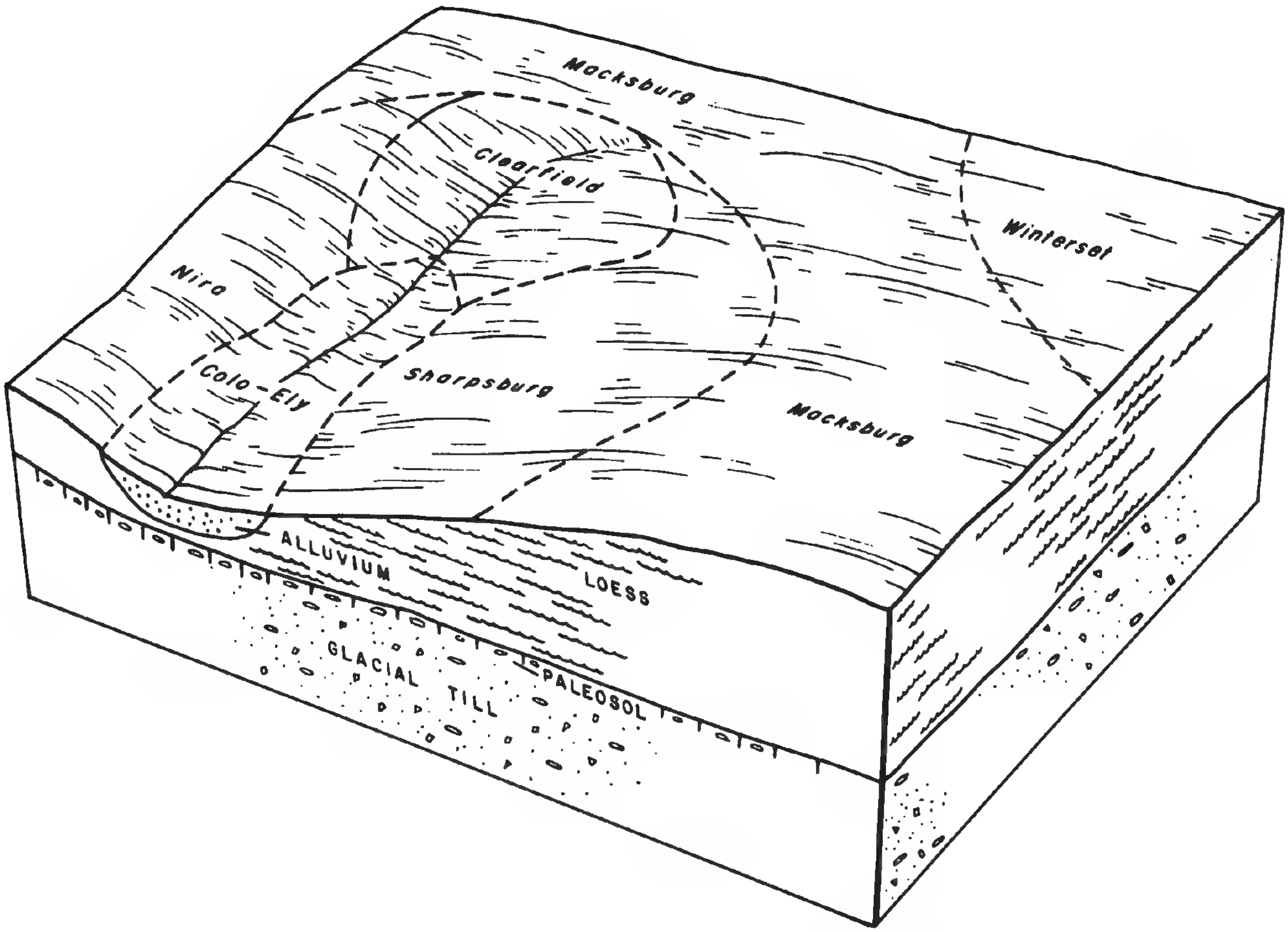


Figure 1.—Relationship of landscape and parent material of soils in the Macksburg-Sharpsburg-Winterset map unit.

lower part. The subsoil is about 29 inches thick. It is brown silty clay loam in the upper part and mottled brown, grayish brown, and yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles.

Winterset soils are nearly level and are poorly drained. They are on broad upland divides. The surface layer typically is black silty clay loam about 16 inches thick. The subsoil is multicolored silty clay loam and silty clay and extends to a depth of about 5 feet.

The minor soils in this unit include Nira, Clearfield, Lamoni, Colo, and Ely soils. The moderately well drained Nira soils are on short convex sides slopes on uplands and on slopes that border drainageways. The poorly drained Clearfield soils are at the head of drainageways and on the upper part of some side slopes. The somewhat poorly drained Lamoni soils are moderately sloping and strongly sloping and are at the head of branching waterways. The poorly drained Colo soils and the somewhat poorly drained Ely soils are in drainageways.

The soils in this unit are well suited to crops. The major crops are corn and soybeans. The corn is used mainly as livestock feed; soybeans is a cash crop. The acreage of this unit that is used as pasture is small and is mainly near farmsteads.

2. Sharpsburg-Nira

Nearly level to moderately sloping, moderately well drained silty clay loam soils that formed in loess; on uplands

This map unit consists of soils on ridgetops and divides, on side slopes, or in drainageways. It makes up about 30 percent of the county. This unit is about 40 percent Sharpsburg soils, 20 percent Nira soils, and 40 percent minor soils (fig. 2).

Sharpsburg soils are moderately well drained and are on upland divides and on the upper part of side slopes. The surface layer, which is eroded, is very dark grayish brown and dark yellowish brown silty clay loam about 8 inches thick. The subsoil is silty clay loam about 29 inches thick. It is brown in the upper part and mottled brown, grayish brown, and yellowish brown in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles.

Nira soils are moderately well drained and are on short, convex side slopes on uplands and on slopes that border drainageways. The surface layer typically is very dark gray and very dark grayish brown silty clay loam about 10 inches thick. The subsoil is about 32 inches thick. It is brown silty clay loam in the upper part, multicolored silty clay loam in the next part, and light gray silty clay loam that has many yellowish red mottles in the lower part. The substratum is light gray silty clay loam that has strong brown mottles. It overlies clayey, grayish-colored gumbotil at a depth between 4 and 8 feet.

The minor soils in this unit include Adair, Clarinda, Lamoni, Shelby, Colo, Ely, and Zook soils. The somewhat poorly drained and moderately well drained Adair soils are on convex side slopes and ridges. The poorly drained Clarinda soils are at the head of drainageways and in narrow bands on side slopes. The somewhat poorly drained Lamoni soils are moderately sloping and strongly sloping and are on the upper part of side slopes and at the head of branching drainageways. The moder-

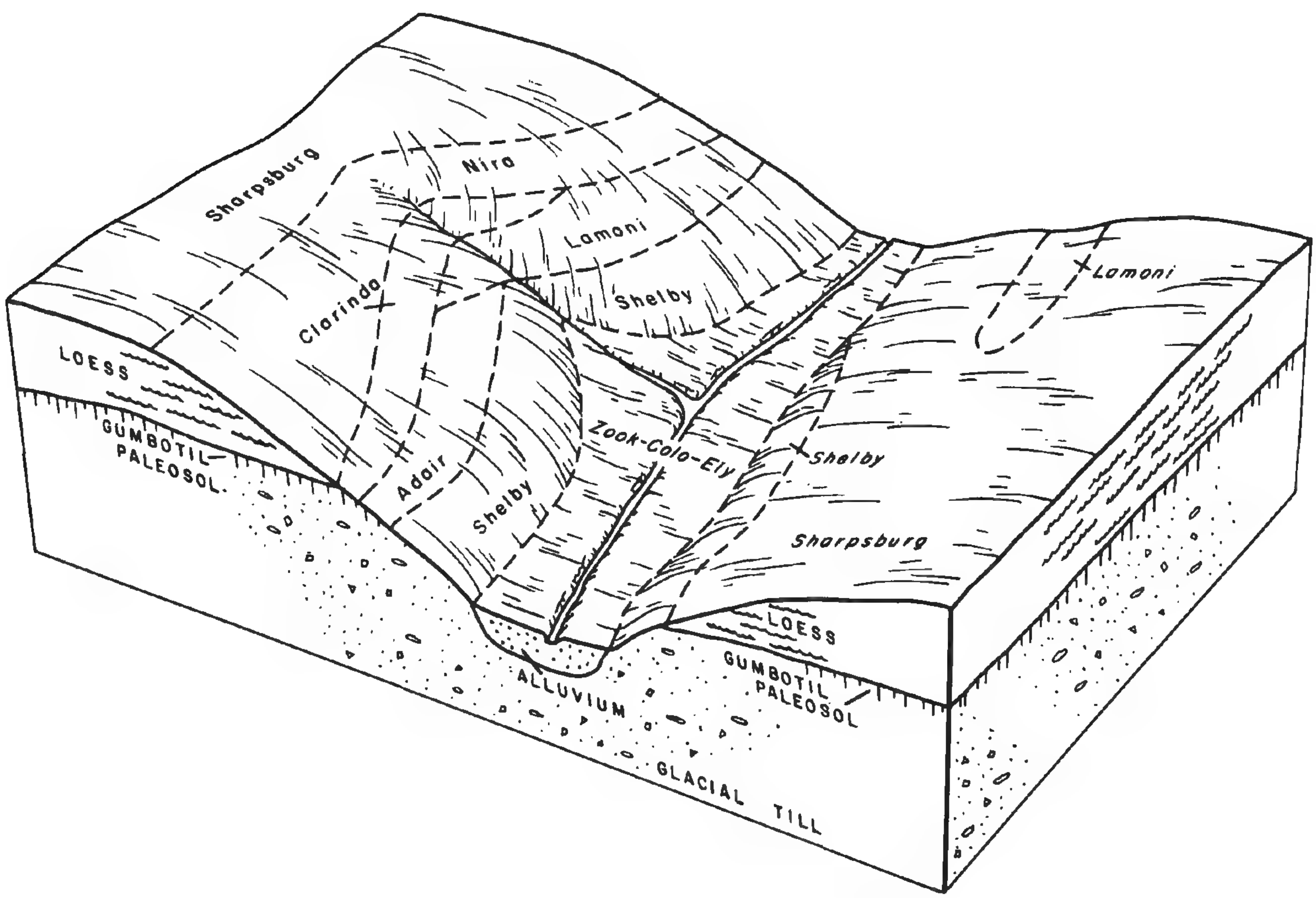


Figure 2.—Relationship of landscape and parent material of soils in the Sharpsburg-Nira map unit.

ately well drained Shelby soils are on upland side slopes along the larger drainageways. The poorly drained Colo and Zook soils and the somewhat poorly drained Ely soils are in drainageways.

In many areas, runoff is rapid. Erosion generally is a moderate hazard, but in some areas it is a severe hazard. The contact zone between the loess and the glacial till is seasonally wet and seepy. Terraces can reduce erosion and thus improve crop production, and interceptor tile can be installed to reduce wetness.

In most areas, the soils on ridgetops and on the less steep side slopes are used for row crops. The soils on the steepest side slopes generally are in meadow or permanent pasture.

3. Sharpsburg-Shelby

Moderately sloping to steep, moderately well drained silty clay loam and clay loam soils that formed in loess and glacial till; on uplands

This map unit consists of soils on rounded ridgetops, on strongly sloping to steep side slopes, and in narrow valleys. The side slopes are dissected by small gullies and short waterways that drain into larger, more stabilized drainageways in small valleys. These drainageways eventually merge with the larger valleys and streams in the county.

This map unit makes up about 44 percent of the county. It is about 30 percent Sharpsburg soils, 25 percent Shelby soils, and 45 percent minor soils (fig. 3).

Sharpsburg soils are moderately well drained and are on ridgetops and the upper part of side slopes. These soils formed in loess. The surface layer, which is eroded, is very dark grayish brown and dark yellowish brown silty

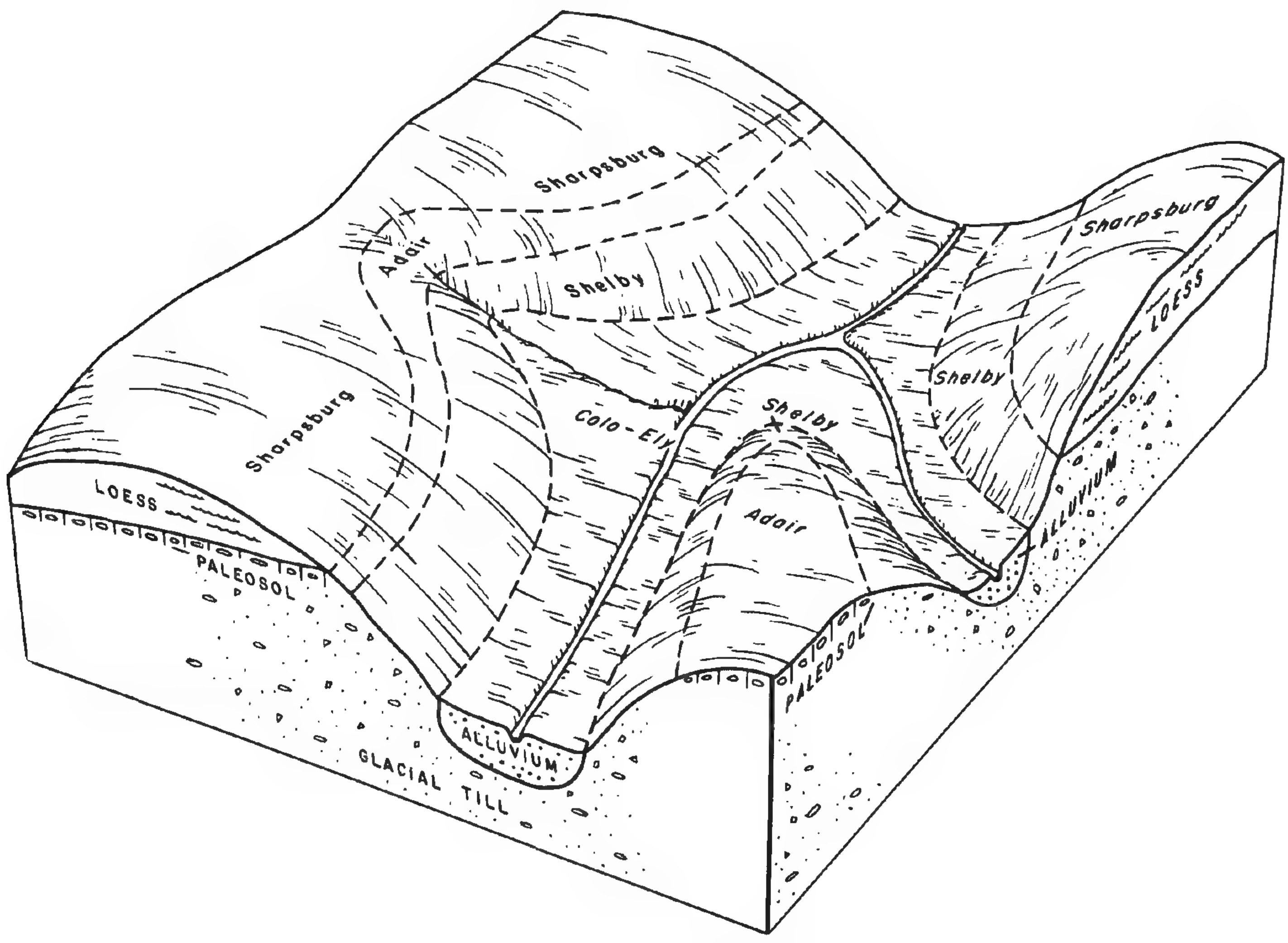


Figure 3.—Relationship of landscape and parent material of soils in the Sharpsburg-Shelby map unit.

clay loam about 8 inches thick. The subsoil is silty clay loam about 29 inches thick.

Shelby soils are moderately well drained and are on the lower and steeper parts of side slopes. These soils formed in glacial till. The surface layer is very dark brown clay loam about 7 inches thick. The subsoil is about 37 inches thick. In the upper part it is dark brown and dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown and yellowish brown, calcareous clay loam that has a few stones and pebbles. In the upper part it has white nodules of lime.

The minor soils in this unit include Adair, Lamoni, Clarinda, Colo, Ely, and Zook soils. The clayey Adair, Lamoni, and Clarinda soils are moderately sloping and strongly sloping and are at the head of branching drainageways and on the upper part of side slopes. The poorly drained Colo and Zook soils and the somewhat poorly drained Ely soils are in drainageways.

The soils on ridgetops that formed in loess are fertile and generally are well suited to crops. The more sloping soils that formed in glacial till are not so well suited to crops; some are suited only to pasture. The cropping systems and management practices that are used vary considerably.

Drainage generally is good in the uplands, except in sidehill areas where seeps are common in wet periods. Areas of wet soils are on narrow bottom lands and at the head of drainageways. Erosion is a major hazard. If row crops are grown, terraces or other erosion-control measures are needed to reduce soil loss. Interceptor tile commonly is needed to reduce wetness in seep areas.

This map unit is mainly used for general livestock farming, and the emphasis is on raising and feeding swine or beef cattle. A large amount of grain and hay is produced.

4. Gara-Ladoga

Gently sloping to steep, moderately well drained and well drained loam and silt loam soils that formed in glacial till and loess; on uplands

This map unit consists of gently sloping and moderately sloping soils on narrow ridgetops and strongly sloping to steep soils on side slopes. These soils are in areas along the major streams and their tributaries. Most of the soils, which have been in mixed timber and grass, have been cleared for cultivation.

This map unit makes up about 13 percent of the county. It is about 40 percent Gara soils, 30 percent Ladoga soils, and 30 percent minor soils (fig. 4).

Gara soils are strongly sloping to steep and are well drained or moderately well drained. These soils are on side slopes. They formed in glacial till. Typically, the surface layer is about 10 inches thick. It is very dark gray loam in the upper part and dark grayish brown and brown loam in the lower part. The subsoil is about 38 inches thick. In the upper part, it is dark yellowish brown clay loam that has strong brown mottles, and in the lower part it is mottled strong brown, grayish brown, and gray clay loam. The substratum is calcareous, mottled, multicolored clay loam.

Ladoga soils are gently sloping and moderately sloping and are moderately well drained. These soils are on ridgetops and on the upper part of side slopes on uplands and on stream benches. They formed in loess. Typically, the surface layer is about 10 inches thick. It is mixed dark grayish brown and brown silt loam. The subsoil is about 40 inches thick. In the upper part, it is brown silty clay loam or heavy silty clay loam that has a few yellowish brown mottles, and in the lower part it is mottled grayish brown and yellowish brown silty clay loam. The substratum is mottled light brownish gray and yellowish brown silty clay loam.

The minor soils in this unit include Armstrong, Colo, Ely, Zook, Dickinson, Clinton, and Sogn soils. The moderately well drained to somewhat poorly drained Armstrong soils are on convex ridgetops and on shoulder slopes of the ridgetops. The poorly drained Colo and Zook soils and the somewhat poorly drained Ely soils are on bottom lands. The well drained Dickinson soils are on uplands along the major streams and their tributaries. The moderately well drained Clinton soils are on convex ridgetops and on the upper part of side slopes. The somewhat excessively drained Sogn soils, which formed in material overlying limestone bedrock, commonly are on steep, dissected uplands along valleys of the major streams and rivers.

In many areas, runoff is rapid, and erosion is a severe hazard. The contact zone between the loess and the glacial till is seasonally wet and seepy. The many waterways in this unit have caused numerous deep, active gullies to form. These gullies, which have trees and brush growing along their side slopes, are more numerous in this unit than in others. Constructing livestock ponds helps to stabilize many of these gullies. In seep areas in cropland, interceptor tile needs to be installed to reduce wetness. Most of the soils on ridgetops and on the upper part of side slopes are used for row crops. A large acreage of this unit is used as meadow, permanent pasture, and woodland.

5. Colo-Zook-Nodaway

Nearly level, moderately well drained and poorly drained silty clay loam and silt loam soils that formed in alluvium; on bottom lands

This map unit consists of soils in valleys along the larger rivers and creeks and their tributaries. It makes up about 7 percent of the county. This unit is about 30

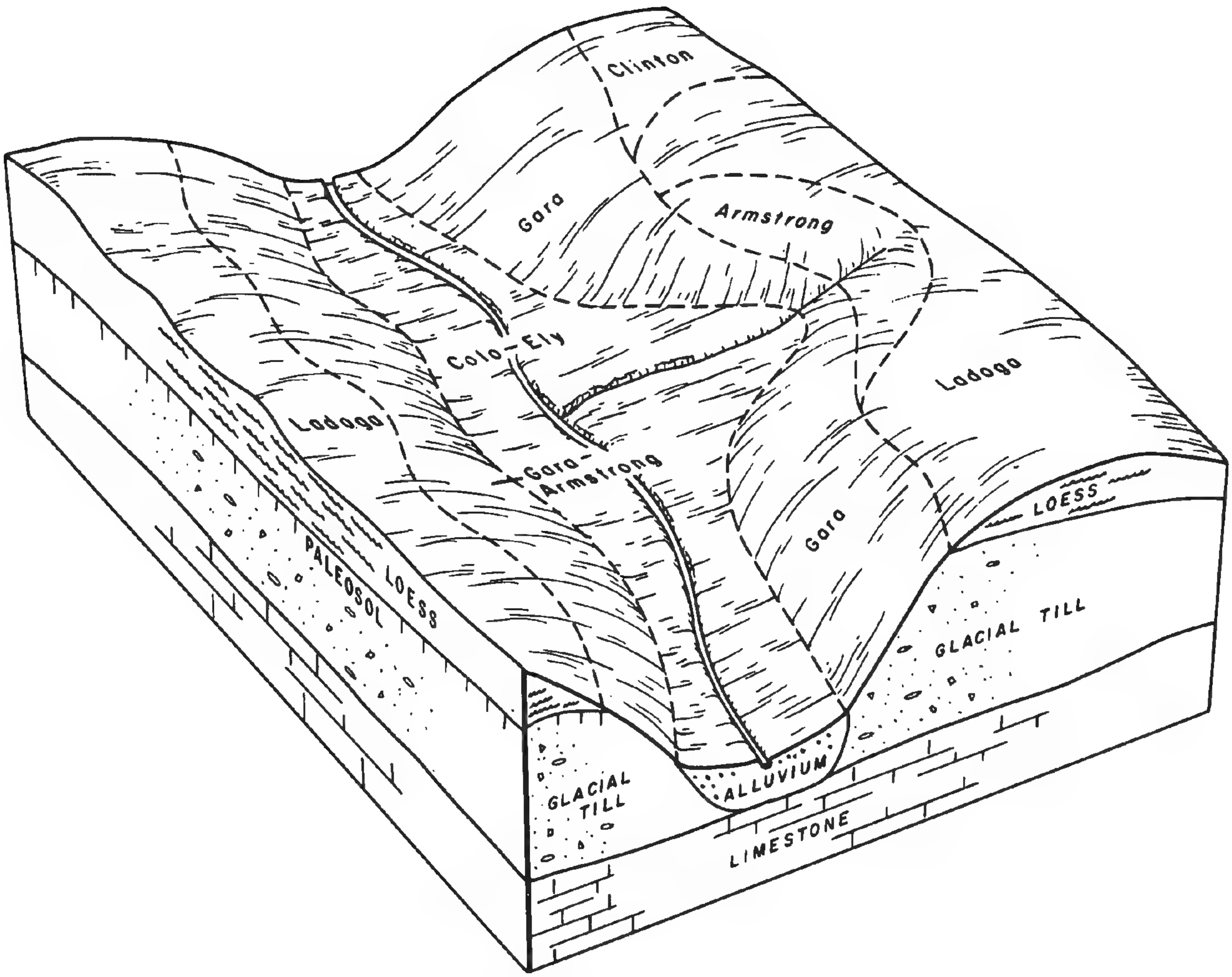


Figure 4.—Relationship of landscape and parent material of soils in the Gara-Ladoga map unit.

percent Colo soils, 25 percent Zook soils, 15 percent Nodaway soils, and 30 percent minor soils (fig. 5).

Colo soils are poorly drained and are on bottom lands. The surface layer is black silty clay loam about 36 inches thick. The subsoil is about 18 inches thick. It is black silty clay loam that has a few soft, brown oxides. The substratum is gray silty clay loam or clay loam and has common soft, brown and black oxides.

Zook soils are poorly drained and are in low, flat areas. The surface layer is black silty clay loam about 30 inches thick. The subsoil is about 34 inches thick. It is very dark gray light silty clay in the upper part, very dark gray light silty clay in the next part, and dark gray and very dark gray heavy silty clay loam in the lower part. The substratum is gray silty clay loam.

Nodaway soils are moderately well drained and generally are adjacent to stream channels. These soils are not adjacent to the channel in some areas where the channel has been straightened. In some areas, several small channels have been cut by streams and rivers during flooding. The surface layer is very dark gray silt loam about 5 inches thick. The substratum, to a depth of more

than 60 inches, is stratified grayish brown, very dark gray, dark gray, and black silt loam that has reddish brown and yellowish brown mottles.

The minor soils in this unit include Judson, Olmitz, Vesser, Humeston, Ackmore, Kennebec, and Ladoga soils. Judson and Olmitz soils are well drained to moderately well drained and are on foot slopes and alluvial fans. Vesser and Humeston soils are somewhat poorly drained to very poorly drained and are on second bottom lands, low stream benches, or alluvial fans. Ackmore soils are somewhat poorly drained and are on bottom lands. Kennebec soils are moderately well drained and are adjacent to rivers and streams. Ladoga soils are moderately well drained and are on high benches.

If outlets for drainage are available, tile generally can be installed on Colo and Zook soils to improve drainage. Zook soils generally remain wet longer in spring than Colo and Nodaway soils; therefore, tile lines need to be spaced closer, and surface drainage can be used if it is feasible. Nodaway soils generally do not need tile drainage, but they are subject to flooding.

This map unit can be used for row crops if timber is cleared and if drainage and flood protection are adequate. In some areas, these soils are near stream channels or old oxbows that are frequently flooded; these soils are used as permanent pasture and meadow.

Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The descriptions, along with the soil maps, can be used to determine the potential of a soil and to manage the soil for food and fiber production; to plan land use and improve soil resources; and to protect and preserve the environment. More information on each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and

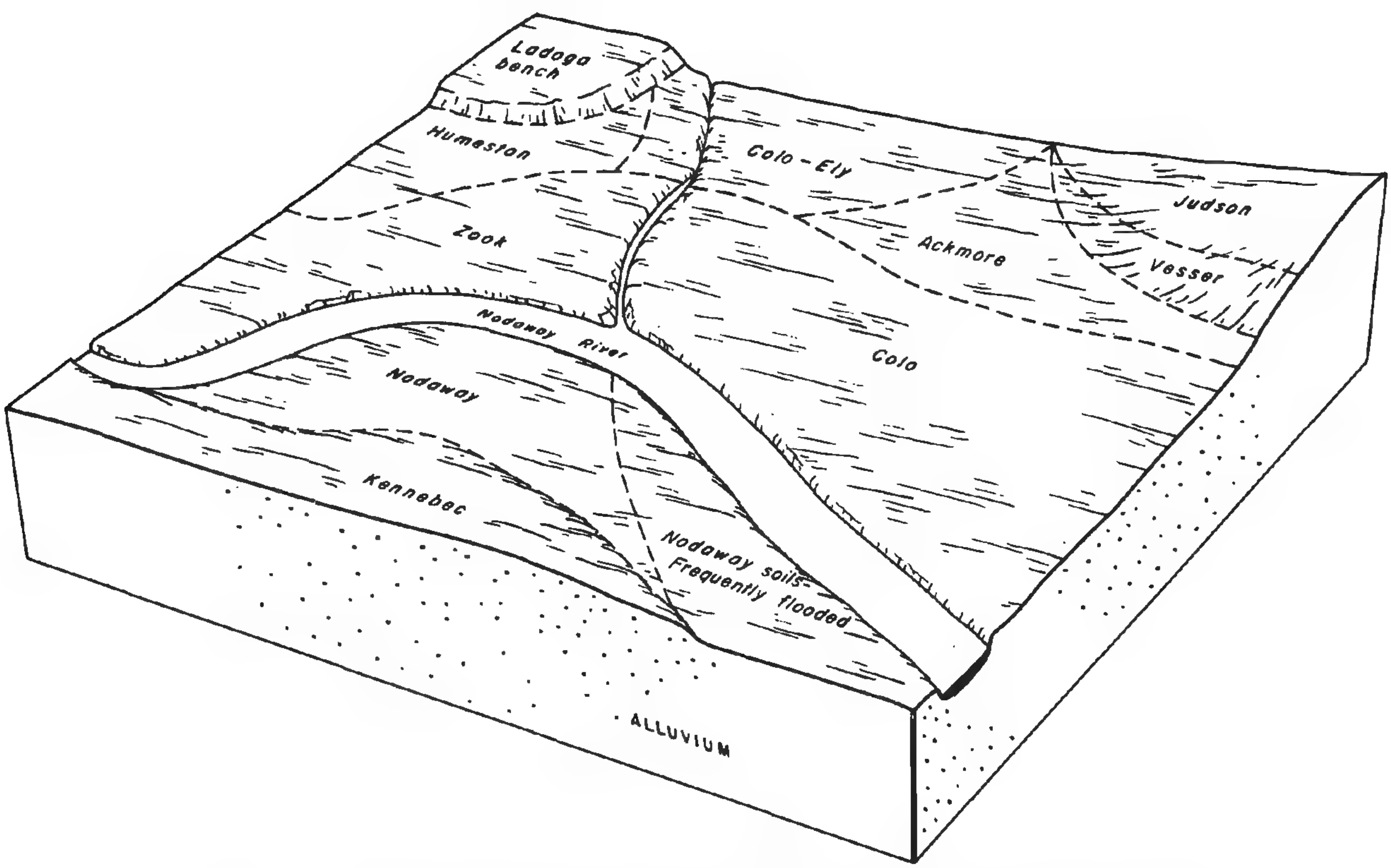


Figure 5.—Relationship of landscape and parent material of soils in the Colo-Zook-Nodaway map unit.

the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have profiles that are almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Adair series, for example, was named for the town of Adair in Adair County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Shelby clay loam, 5 to 9 percent slopes, is one of several phases within the Shelby series.

Some map units are made up of two or more major soils. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small that they cannot be shown separately on the soil maps. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Dickinson-Sharpsburg complex, 5 to 9 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Many mapped areas include areas that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Pits-Dumps complex is an example. These areas are too small to be delineated and are identified by a special symbol on the soil maps.

The acreage and proportionate extent of each map unit are given in table 4. Additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Soil descriptions

8B—Judson silty clay loam, 2 to 5 percent slopes. This is a moderately well drained or well drained, gently sloping soil on slightly concave or plane alluvial fans and foot slopes. This soil is in valleys throughout the county.

Typically, the surface layer is silty clay loam about 29 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is silty clay loam about 18 inches thick. It is brown and dark brown in the upper part and mottled yellowish brown, dark yellowish brown, and grayish brown in the lower part. The substratum is light gray, brown, and dark yellowish brown silty clay loam. In a few small areas, recently deposited silty material, 5 to 12 inches thick, is on the surface. This material generally is lighter in color and lower in organic matter content than the soil material in the surface layer described as typical of this Judson soil.

Included in mapping are small areas of Ely soils on the lower part of slopes and Sharpsburg and Ladoga soils on the steeper slopes.

Permeability is moderate, and the available water capacity is high. Runoff is medium. The content of available phosphorus and available potassium is low. If this soil has not been limed, it generally is acid in the surface layer. In cultivated areas, the plow layer is about 5 percent organic matter. Organic matter in the solum amounts to about 105 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, and hay and to use as pasture. Runoff from the soils on uplands causes a slight hazard of erosion and wetness for short periods in spring. The major hazards in using this soil are flooding of short duration and the accumulation of silty sediment from soils upslope. Contour farming, conservation tillage, and using terraces on adjacent upland soils help to control erosion. A diversion terrace can be placed along the base of adjacent upland slopes to help reduce overflow and deposition.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. Runoff from adjacent upland slopes and medium to low strength are limitations to the use of this soil as building sites and as sites for local roads.

Capability subclass IIe.

8C—Judson silty clay loam, 5 to 9 percent slopes. This is a moderately well drained or well drained, moderately sloping soil on slightly concave or plane alluvial fans and foot slopes. This soil is along drainageways in widely scattered areas throughout the county.

Typically, the surface layer is silty clay loam about 29 inches thick. It is dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is silty clay loam about 18 inches thick. It is brown and dark brown in the upper part and mottled yellowish brown,

dark yellowish brown, and grayish brown in the lower part. The substratum is light brown, gray, and dark yellowish brown silty clay loam. In some small areas this soil has silty overwash material, 5 to 12 inches thick, on the surface. The accumulation of silty material in spring can damage newly planted crops. The silty overwash generally is lower in organic matter content and has poorer tilth than the typical Judson soil.

Included in mapping are small areas of Ely soils that are more gently sloping and Sharpsburg and Ladoga soils that are steeper than this Judson soil.

Permeability is moderate, and the available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is low. If this soil has not been limed, it generally is acid in the surface layer. In cultivated areas the plow layer is about 5 percent organic matter. Organic matter in the solum amounts to about 100 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, and hay and to use as pasture. The soil lost through erosion is replaced by sediment from soils upslope. The major hazards in using this soil are flooding of short duration and the accumulation of silty sediment from soils upslope. Contour farming, conservation tillage, and using terraces on adjacent upland soils help to reduce erosion. A diversion terrace can be placed along the base of adjacent upland slopes to help reduce overflow and deposition.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. Runoff from adjacent upland slopes and medium to low strength are limitations to the use of this soil as building sites and as sites for local roads.

Capability subclass IIIe.

11B—Colo-Ely silty clay loams, 2 to 5 percent slopes. This map unit consists of poorly drained and somewhat poorly drained, gently sloping soils on bottom lands (fig. 6). Typically, the Colo soil is along waterways. The Ely soil is at the base of upland slopes and is in

Figure 6.—An intermittent stream in an area of gently sloping Colo silty clay loam in a valley near Greenfield, Iowa. Ely silty clay loam is along the edge of the valley. Sloping Sharpsburg and Shelby soils are on uplands in the background.

uniform bands along the boundary of this map unit. In many places, the areas of this unit are cut by channels or gullies and cannot be crossed by farm machinery. The areas are as much as a mile or more long but generally are only 150 to 400 feet wide.

The Colo soil makes up about 60 percent of this complex and the Ely soil about 20 percent. The Colo and Ely soils are in such an intricate pattern on the landscape that it was not practical to map them separately at the scale used.

Typically, the surface layer of the Colo soil is black silty clay loam about 36 inches thick. The subsoil, which is about 18 inches thick, is black silty clay loam that has a few soft, brown oxides. The substratum is silty clay loam or clay loam and has common, soft, brown and black oxides.

Typically, the surface layer of the Ely soil is silty clay loam about 22 inches thick. It is very dark brown in the upper part and black and very dark gray in the lower part. The subsoil is silty clay loam about 44 inches thick. It is very dark grayish brown in the upper part and mottled, dark grayish brown in the lower part.

Included in mapping and making up about 20 percent of the unit are small areas of Judson and Olmitz soils on foot slopes; and Vesser, Ackmore, and Zook soils on the lower bottom lands. Also included in this map unit are some valleys that have a gully as much as 5 feet deep and 20 feet wide.

The Colo soil has moderately slow permeability, and the Ely soil has moderate permeability. The available water capacity is high. Runoff is slow on the Colo soil and medium on the Ely soil. The content of available subsoil phosphorus and of available potassium is medium in the Colo soil and very low in the Ely soil. If these soils have not been limed, they generally are acid in the surface layer. The plow layer is 5 to 7 percent organic matter. Organic matter in the solum amounts to about 110 tons per acre.

These soils are used mainly for cultivated crops or hay. They are well suited to corn, soybeans, oats, and hay and to use as pasture. They are seasonally wet because of overflow and the high water table. These soils are farmed with surrounding soils because the areas of this unit generally are too small or too narrow to be farmed separately. The major limitation is flooding in wet periods.

Tile drainage on the Colo soil and a diversion terrace along the base of adjacent upland slopes can help to reduce wetness and overflow. If these soils are used as pasture, proper stocking rates, pasture rotation, and timely deferment of grazing when the soils are very wet reduce compaction and help to keep pasture and soil in good condition.

These soils are poorly suited to building site development and onsite waste disposal. The hazard of flooding, seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and diversion terraces help to reduce wetness and flooding. Local roads need to be built up using a more suitable base material, and they should be graded to shed water. The bottom of sewage lagoons needs to be sealed.

Capability subclass IIw.

13B—Vesser-Nodaway silt loams, 2 to 5 percent slopes. This map unit consists of moderately well drained to poorly drained soils. These soils generally are on bottom lands adjacent to a large stream channel or are in side valleys that drain into a larger valley. Vesser silt loam is in slightly higher lying areas along the borders of the mapped areas. It makes up about 50 percent of the unit. Nodaway silt loam is adjacent to the stream channel and is in the middle of the mapped areas. It makes up about 30 percent of the unit. These soils are so intricately mixed or the areas of each soil are so small that it was not practical to separate the soils in mapping at the scale used.

Typically, the surface layer of the Vesser soil is very dark gray and black silt loam about 15 inches thick. The subsurface layer is very dark gray to gray, platy silt loam about 18 inches thick. The subsoil is about 27 inches thick. It is gray and dark gray silty clay loam that has reddish brown mottles.

Typically, the surface layer of the Nodaway soil is very dark gray silt loam about 5 inches thick. The substratum is more than 40 inches thick. It is stratified very dark gray, very dark grayish brown, and grayish brown silt loam. Above a depth of 60 inches, the soil material has a few yellowish brown and reddish brown mottles.

Included in mapping are small areas of Colo and Kennebec silt loams. In places, sandy alluvial soils are along the channel. These soils make up about 20 percent of this unit.

Permeability of the Vesser soil is moderate, and the available water capacity is high. Runoff is slow or medium. The content of available phosphorus is medium, and that of available potassium is low. If this soil has not been limed, it generally is acid in the surface layer.

Permeability of the Nodaway soil is moderate, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low, and that of available potassium is low to very low. If this soil has not been limed, it generally is neutral or slightly acid in the surface layer.

The average plow layer in this map unit is about 3 percent organic matter. On the average, organic matter in the solum amounts to about 50 tons per acre.

These soils are used mainly as pasture. They are suited to use as hayland and are well suited to use as pasture. Unless they are protected and drained, these soils are subject to stream overflow during a hard rain and have a high water table in wet periods. If these soils

are used for crops, levees or dikes and tile drainage, where needed, and a diversion terrace along the base of adjacent upland slopes help to reduce overflow and wetness. If these soils are used as pasture, preventing overgrazing and deferring grazing when the soils are very wet can reduce surface compaction.

These soils are poorly suited to building site development and onsite waste disposal because of wetness and the hazard of flooding. Low strength is a limitation to the use of these soils as building sites and as sites for local roads.

Capability subclass IIw.

24C—Shelby clay loam, 5 to 9 percent slopes. This is a moderately well drained, moderately sloping soil on convex side slopes and narrow ridges on uplands. The areas are irregular in shape.

Typically, the surface layer is very dark brown and very dark grayish brown clay loam about 11 inches thick (fig. 7). The subsoil is about 39 inches thick. In the upper part, it is dark brown to dark yellowish brown clay loam, and in the lower part, it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish brown, and dark yellowish brown calcareous clay loam that has a few stones and pebbles. In the upper part, it has white nodules of lime. In some areas where this soil is near the base of slopes or is adjacent to a waterway, the surface layer is darker and thicker than is typical.

Included in mapping are small areas of Sharpsburg, Clarinda, Lamoni, and Adair soils on shoulder slopes above this Shelby soil.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high. If this soil has not been limed, it generally is acid in the surface layer. The plow layer is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 70 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is suited to corn, soybeans, small grains, grasses and legumes for hay or pasture, and trees.

If this soil is used for cultivated crops, erosion is a hazard. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. Seepage and slope are limitations to the use of this soil as sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to use as building sites.

Capability subclass IIIe.

24C2—Shelby clay loam, 5 to 9 percent slopes, moderately eroded. This is a moderately well drained, moderately sloping soil on convex side slopes and narrow ridges on uplands. The areas commonly are long and narrow.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer. This plow layer directly overlies the clay loam subsoil. The subsoil is about 35 inches thick. In the upper part, it is dark brown

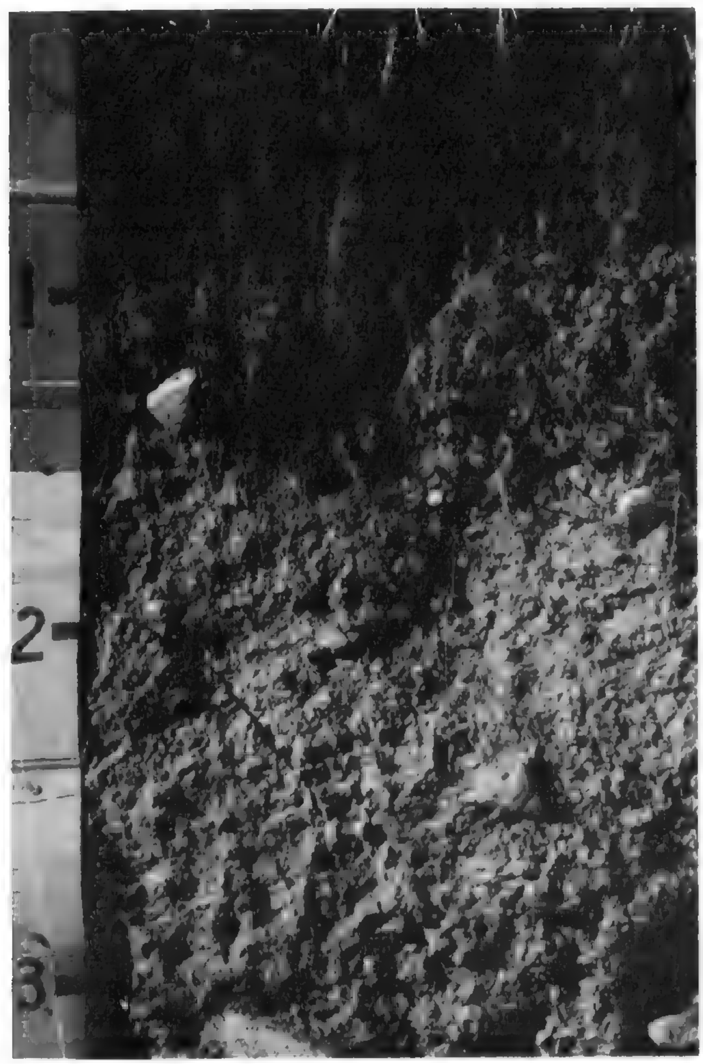


Figure 7.—Profile of Shelby clay loam. The dark surface layer indicates that the amount of organic matter in this uneroded soil is high.

to dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish brown, and dark yellowish brown, calcareous clay loam that has a few stones and pebbles. In the upper part, it has white nodules of lime. In areas where this soil is severely eroded, the subsoil is exposed at the shoulder of slopes or near drains on hillsides.

Included in mapping are small areas of Clarinda, Adair, and Lamoni soils on shoulder slopes above this Shelby soil.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high. If this soil has not been limed, it generally is acid in the surface layer. The plow layer is about 2 percent organic matter. Organic matter, which is mostly in the plow layer, amounts to about 35 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is suited to corn, soybeans, small grains, grasses and legumes for hay or pasture, and trees.

If this soil is used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and the use of terraces also help to control erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. To maintain a high yield and to maintain or improve soil tilth, this soil generally requires more nitrogen than the less eroded Shelby soils.

Using this soil as pastureland or hayland also is effective in controlling erosion. Overgrazing, however, can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. Seepage and slope are limitations to the use of this soil as sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to use as building sites.

Capability subclass IIIe.

24D—Shelby clay loam, 9 to 14 percent slopes. This is a moderately well drained, strongly sloping soil on convex side slopes and narrow ridges on uplands. There are many small drainageways on hillsides. The areas generally are long and narrow. They commonly extend horizontally along hillsides and around nose slopes.

Typically, the surface layer is very dark brown and very dark grayish brown clay loam about 11 inches thick. The subsoil is about 37 inches thick. In the upper part, it is dark brown to dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish brown, and dark yellowish brown, calcareous clay loam that has a few stones and pebbles. In the upper part, it has white nodules of lime. In some areas where this soil is near the base of slopes or is adjacent to a waterway, the surface layer is darker and thicker than is typical.

Included in mapping are small areas of Clarinda, Lamoni, and Adair soils on shoulder slopes at a higher elevation than this Shelby soil. Also included are small areas of Arbor and Sharpsburg soils on smooth or concave slopes at a lower elevation.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high. If this soil has not been limed, it generally is acid in the surface layer. The plow layer is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 65 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is suited to corn, soybeans, small grains, grasses and legumes for hay or pasture, and trees.

If this soil is used for cultivated crops, erosion is a hazard. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and the use of terraces also help to control erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. Seepage and slope are limitations to the use of this soil as sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to use as building sites.

Capability subclass IIIe.

24D2—Shelby clay loam, 9 to 14 percent slopes, moderately eroded. This is a moderately well drained, strongly sloping soil on convex side slopes and narrow ridges on uplands. There are many small drainageways on hillsides. The areas generally are long and narrow. They commonly extend horizontally along hillsides and around nose slopes (fig. 8).

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer, and pebbles and stones are common. This plow layer directly overlies the clay loam subsoil. The subsoil is about 34 inches thick. In the upper part, it is dark brown to dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish

Figure 8.—Shelby clay loam is in the foreground and on the hillside in the background. Sharpsburg silty clay loam is on the upland ridge, and Colo and Ely silty clay loams are in the valley.

brown, and dark yellowish brown, calcareous clay loam that has a few stones and pebbles. In the upper part, it has white nodules of lime. In areas where this soil is in the concave part of drainageways and receives sediment from soils upslope, the surface layer is thicker and darker than is typical. In some areas, this soil is severely eroded, and the subsoil is exposed at the shoulder of slopes.

Included in mapping, generally along the upslope boundaries of this unit, are small areas of Adair and Lamoni soils. Included in less sloping areas are small areas of Arbor and Sharpsburg soils.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high. If this soil has not been limed, it generally is acid in the surface layer. The plow layer is about 2 percent organic matter. Organic matter, which is mostly in the plow layer, amounts to about 30 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is suited to corn, soybeans, small grains, grasses and legumes for hay or pasture, and trees.

If this soil is used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and the use of terraces also help to reduce erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. To maintain a high yield and to maintain or improve tilth, this soil generally requires more nitrogen and greater production inputs than the less eroded Shelby soils.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. Seepage and slope are limitations to the use of this soil as sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to use as building sites.

Capability subclass IIIe.

24E—Shelby clay loam, 14 to 18 percent slopes. This is a moderately well drained, moderately steep soil on convex side slopes and narrow ridges on uplands. The areas generally are long and narrow. They generally extend along hillsides and around nose slopes.

Typically, the surface layer is very dark brown and very dark grayish brown clay loam about 10 inches thick. The subsoil is about 35 inches thick. In the upper part, it is dark brown to dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish brown, and dark yellowish brown, calcareous clay loam that has a few stones and pebbles. White nodules of lime are in the upper part of the substratum.

Included in mapping are small areas of Lamoni and Adair soils along shoulder slopes at a higher elevation than this Shelby soil. Also included are small areas of Arbor and Sharpsburg soils on smooth or concave slopes at a lower elevation.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high. If this soil has not been limed, it generally is acid in the surface layer. The plow layer is about 3 percent organic matter. Organic matter in the solum amounts to about 60 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is moderately suited to corn, soybeans, and small grains. It is suited to grasses and legumes for hay or pasture and to trees.

If this soil is used for cultivated crops, erosion is a severe hazard. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and the use of terraces also help to reduce erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is poorly suited to building site development and onsite waste disposal. Slope is a limitation to the use of this soil as sewage lagoons or building sites. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IVe.

24E2—Shelby clay loam, 14 to 18 percent slopes, moderately eroded. This is a moderately well drained, moderately steep soil on convex side slopes on uplands. It generally is on the lower part of dissected slopes, but in some areas it is on ridgetops and on the upper and lower parts of side slopes. The areas generally are irregularly shaped bands or strips that extend horizontally along hillsides and around nose slopes.

In cultivated areas, the surface layer is very dark grayish brown clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer, and pebbles and stones are common. This plow layer directly overlies the subsoil. The subsoil is about 33 inches thick. In the upper part, it is dark brown to dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish brown, and dark yellowish brown, calcareous clay loam that has a few stones and pebbles. White nodules of lime are in the upper part of the substratum. In places, the subsoil is exposed at the shoulder of slopes or near drains on hillsides.

Included in mapping, generally along the upslope boundaries of this unit, are small areas of Lamoni and Adair soils. Also included, in areas where slopes are smooth, are an uneroded Shelby soil and Sharpsburg soils.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high. If this soil has not been limed, it generally is acid in the surface layer. The plow layer is about 2 percent organic matter. Organic matter, which is mostly in the plow layer, amounts to about 30 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is moderately suited to corn, soybeans, and small grains. It is best suited to grasses and legumes for hay and pasture and to trees.

If this soil is used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and the use of terraces also help to control erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. To maintain a high yield and to maintain or improve tilth, this soil generally requires more nitrogen and greater production inputs than the less eroded Shelby soils.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is poorly suited to building site development and onsite waste disposal. Slope is a limitation to the use of this soil for sewage lagoons or as building sites. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IVe.

24F2—Shelby clay loam, 18 to 25 percent slopes, moderately eroded. This is a moderately well drained, steep soil on side slopes on uplands. The areas generally are long and narrow. They extend along hillsides and around nose slopes.

In cultivated areas, the surface layer is dark grayish brown clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer. This plow layer directly overlies the clay loam subsoil. The subsoil extends to a depth of 30 inches. In the upper part, it is dark brown to dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish brown, and dark yellowish brown, calcareous clay loam that has a few stones and pebbles. White nodules of lime are in the upper part of the substratum. In uncultivated areas, the surface layer is very dark brown and very dark grayish brown light clay loam about 10 inches thick. In some small areas, this soil is severely eroded, and the subsoil is exposed at the shoulder of slopes or near drains on hillsides. Uneroded Shelby soils are included in other small areas.

Included in mapping are small areas of Adair and Lamoni soils on the less sloping shoulder slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high. If this soil has not been limed, it generally is acid in the surface layer. The plow layer is about 2 percent organic matter. Organic matter, which is mostly in the plow layer, amounts to about 25 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is not suited to corn, soybeans, or small grains. It is suited to grasses and legumes for hay and pasture and to trees. If this soil is used for cultivated crops, erosion can cause further damage.

Using this soil as pastureland or hayland helps to control erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is poorly suited to building site development and onsite waste disposal. The steep slopes are a limitation to the use of this soil for sewage lagoons or as building sites. Permeability is a limitation to use as septic tank filter fields.

Capability subclass VIe.

51—Vesser silt loam, 0 to 2 percent slopes. This is a somewhat poorly drained or poorly drained, nearly level soil. This soil is on high first bottom lands of the Nodaway, Middle, and Grand Rivers and their major tributaries. The areas vary in shape and size but generally are roughly parallel to the stream channel.

Typically, the surface layer is very dark gray or black silt loam about 15 inches thick. The subsurface layer is very dark gray or gray, platy silt loam about 18 inches thick. The subsoil is about 27 inches thick. It is dark gray silty clay loam that has reddish brown mottles. In some areas the surface layer is only 7 to 10 inches thick.

Included in mapping are small areas of Humeston and Zook soils in slack-water areas and Colo soils near channels.

Permeability is moderate, and the available water capacity is high. Runoff is slow. The content of available phosphorus is medium, and that of available potassium is low. If this soil has not been limed, it generally is acid in the surface layer. The plow layer, which is 8 inches thick, is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 70 tons per acre.

This soil is used mainly for cultivated crops and as pasture. If this soil is protected from flooding and adequately drained, it is well suited to corn, soybeans, oats, and alfalfa. It is suited to pasture grasses. The main limitation is wetness. In some areas this soil is in slight depressions and frequently is ponded after a heavy rain or when waterways overflow. The water table fluctuates. A diversion terrace placed on foot slopes above this soil and tile drainage help to reduce wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction.

This soil is poorly suited to building site development and onsite waste disposal. The hazard of flooding, seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and diversion terraces help to reduce wetness and flooding. Local roads need to be built up using a more suitable base material, and they should be graded to shed water. The bottom of sewage lagoons needs to be sealed.

Capability subclass IIw.

54—Zook silty clay loam, 0 to 2 percent slopes. This is a poorly drained, nearly level soil on low, flat flood plains and in drainageways. This soil is on smooth bottom lands of the larger streams. The areas generally are irregular in shape but are longer than they are wide. They are roughly parallel to the stream channel.

Typically, the surface layer is black silty clay loam about 30 inches thick. The subsoil is about 34 inches thick. It is very dark gray silty clay in the upper part, very dark gray silty clay in the next part, and dark gray and very dark gray silty clay loam in the lower part. In some areas, the black surface layer is 24 to 30 inches thick. In other areas, it is covered by several inches of very dark grayish brown silty overwash. In some small areas, the surface layer is silty clay.

Permeability is slow, and the available water capacity is high. Runoff is slow or very slow. The content of available phosphorus and potassium is low. If this soil has not been limed, it generally is acid in the surface layer. The plow layer, which is 8 inches thick, is 5 to 7

percent organic matter. Organic matter in the surface layer, to a depth of 24 inches, amounts to about 110 tons per acre.

This soil is used mainly for cultivated crops and as pasture. If this soil is protected from flooding and adequately drained, it is well suited to corn, soybeans, oats, and alfalfa. It is suited to grass. In some areas, this soil is ponded after a heavy rain. If this soil is worked or grazed when it is too wet, the surface can become compacted. Surface and tile drainage help to reduce wetness. If this soil is used as pasture, deferring grazing when the soil is very wet can reduce surface compaction.

This soil is poorly suited to building site development and onsite waste disposal. The hazard of flooding, the seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and the use of diversion terraces help to reduce wetness and flooding. A more suitable base material should be used to build up local roads, and the roads should be graded to shed water.

Capability subclass IIw.

54+—Zook silt loam, overwash, 0 to 2 percent slopes. This is a poorly drained, nearly level soil on low, flat flood plains and in drainageways. It is on smooth bottom lands of the larger streams. In many areas where this soil is adjacent to foot slopes, small upland drainageways have deposited silty material over the original surface layer. In other areas, the sediment has been deposited by floodwaters.

Typically, the surface layer is stratified very dark gray, dark gray, and dark grayish brown silt loam overwash sediment about 16 inches thick. Below that, the original surface layer is black silty clay loam about 8 inches thick. The subsoil is about 34 inches thick. It is black silty clay in the upper part, very dark gray silty clay in the next part, and dark gray and very dark gray silty clay loam in the lower part.

Included in mapping are small areas of Colo and Ackmore soils. These soils generally are near the channels.

Permeability is slow, and the available water capacity is high. Runoff is slow or very slow. The content of available phosphorus and potassium is low. If this soil has not been limed, it generally is slightly acid in the surface layer. The plow layer, which is 8 inches thick, is about 4 percent organic matter. Organic matter in the surface layer, to a depth of 24 inches, amounts to about 90 tons per acre.

This soil is used mainly for cultivated crops and as pasture. If this soil is adequately drained and protected from flooding, it is well suited to corn, soybeans, oats, and alfalfa. It is suited to pasture grass. This soil is more productive and is easier to farm than Zook silty clay loam because the plow layer dries more quickly. The silty surface layer of this Zook soil is more friable and has better tilth than that of Zook soils that do not have overwash; however, if this soil is tilled when it is wet, the surface compacts. Surface and tile drainage help to reduce wetness. If this soil is used as pasture, deferring grazing when the soil is very wet can reduce surface compaction.

This soil is poorly suited to building site development and onsite waste disposal. The hazard of flooding, seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and the use of diversion terraces help to reduce wetness and flooding. A more suitable base material should be used to build up local roads, and the roads should be graded to shed water.

Capability subclass IIw.

69C—Clearfield silty clay loam, 5 to 9 percent slopes. This is a poorly drained or somewhat poorly drained, moderately sloping soil. This soil is in seepy areas in coves around the head of drainageways on uplands and on the short upper part of slopes between waterways (fig. 9). The areas commonly are roughly semicircular in shape.

Typically, the surface layer is black silty clay loam about 14 inches thick. The subsoil extends to a depth of about 76 inches. To a depth of about 26 inches, the subsoil is mixed gray, dark gray, and grayish brown silty clay loam that has yellowish brown and dark red mottles. Below that, the subsoil is buried gumbotil. It is dark gray or gray clay or silty clay that has brownish mottles.

Included in mapping are small areas of Nira soils on the higher, more convex part of slopes and small areas of Clarinda soils on the lower part of slopes.

Permeability is moderately slow to a depth of 40 inches and very slow below that depth. The available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is low. If this soil has not been limed, it generally is medium acid in the surface layer. In cultivated areas, the plow layer, which is 8 inches thick, is 3 to 4 percent organic matter. Organic matter content in the solum amounts to about 80 tons per acre.

This soil is used mainly for cultivated crops and hay and as pasture. It is moderately suited to corn, soybeans, oats, and alfalfa. This soil is suited to pasture grasses. It is poorly suited to trees. This soil is susceptible to wetness, seepiness, and erosion. It commonly is managed with adjacent soils because the areas of this soil generally are small. The main hazards are wetness and erosion. In wet periods, this soil is seepy unless it is protected by interceptor tile. Contour farming, conservation tillage, and interceptor tile help to reduce erosion and wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development and onsite waste disposal because of wetness. It has low strength. Permeability is a limitation to the use of this

Figure 9.—Typical landscape of Clearfield silty clay loam, 5 to 9 percent slopes, at the upper end of a drainageway on uplands.

soil as septic tank filter fields. A more suitable base material is needed for local roads.

Capability subclass IIIw.

69C2—Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded. This is a poorly drained or somewhat poorly drained, moderately sloping soil. This soil is in seepy areas in coves around the head of drainageways on uplands. The areas commonly are roughly semicircular in shape.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. Plowing has mixed some subsoil material with the surface layer. The subsoil extends to a depth of about 76 inches. To a depth of about 26 inches, it is mixed gray, dark gray, and grayish brown silty clay loam that has yellowish brown and dark red mottles. Below that, the subsoil is buried gumbotil. It is dark gray or gray clay or silty clay that has brownish mottles. Clearfield soils that are not eroded are included in some small areas.

Included in mapping are small areas of Nira soils on the higher, more convex part of slopes. Also included are areas of Clarinda and Lamoni soils near the lower boundary of this unit.

Permeability is moderately slow to a depth of 34 inches and very slow below that depth. The available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is low. If this soil has not been limed, it generally is medium acid in the surface layer. The plow layer is about 2 percent organic matter. Organic matter, which is mostly in the plow layer, amounts to about 35 tons per acre.

This soil is used mainly for cultivated crops and hay and as pasture. It is moderately suited to corn, soybeans, oats, and alfalfa. This soil is suited to pasture grasses. It is poorly suited to trees. This soil is susceptible to wetness. If tile is not installed, the subsoil is wet and seepy. In most areas, this soil is managed with adjacent soils because the areas of this soil are small.

In general, this soil requires a higher level of management than the uneroded Clearfield soil; it commonly is cloddy when tilled, and thus seedbed preparation is more difficult and the production inputs required are greater. This soil is more erodible than the uneroded Clearfield soil because the surface layer is in poorer physical condition. The main hazards are wetness and erosion. In wet periods, this soil is seepy unless it is protected by interceptor tile. Contour farming, conservation tillage, and interceptor tile help to reduce erosion and wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development and onsite waste disposal because of wetness. This soil has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. A more suitable base material is needed for local roads. Permeability is a limitation to the use of this soil as septic tank filter fields.

Capability subclass IIIw.

76B—Ladoga silt loam, 2 to 5 percent slopes. This is a moderately well drained, gently sloping soil on upland divides and side slopes. Slopes are slightly convex. The areas generally are long and narrow.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is about 44 inches thick. It is brown silty clay loam that has a few dark yellowish brown mottles. The substratum is light brownish gray silty clay loam that has yellowish brown mottles. In cultivated areas, the plow layer is very dark grayish brown silt loam and is a mixture of material from the surface and subsurface layers. In some small, nearly level areas, this soil has a thinner surface layer. In some areas where this soil is at the head of drainageways, it has a mottled subsoil and is not so well drained.

Included in mapping are small areas of Sharpsburg soils on the more gentle slopes and Clinton soils on the more convex slopes. Also included are sandy Dickinson soils in a few widely scattered areas.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is medium, and that of available potassium is very low. If this soil has not been limed, it generally is medium acid in the surface layer. The surface layer is about 3 percent organic matter. Organic matter in the solum amounts to about 50 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is well suited to corn, soybeans, oats, hay, and trees and as pasture. This soil is susceptible to erosion. Contour farming, conservation tillage, and terraces on long slopes help to reduce erosion. If this soil is used as pasture, preventing overgrazing can reduce runoff and erosion.

This soil is suitable for building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. A more suitable base material is needed for local roads. The moderately slow permeability of this soil is a limitation to use as septic tank filter fields.

Capability subclass IIe.

76C—Ladoga silt loam, 5 to 9 percent slopes. This is a moderately well drained, moderately sloping soil on the edge of convex upland divides and on side slopes between waterways. The areas generally are long and narrow. They commonly extend horizontally for one-half mile or more.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is about 40 inches thick. In the upper part, it is brown silty clay loam that has a few yellowish brown mottles, and in the lower part it is mottled grayish brown and dark yellowish brown silty clay loam. The substratum is light brownish gray silty clay loam that has yellowish brown mottles. In cultivated areas, the plow layer is very dark grayish brown silt loam and is a mixture of material from the surface and subsurface layers.

Included in mapping are small areas of Nira and Sharpsburg soils at the head of drainageways. Also included are sandy Dickinson soils in a few widely scattered areas.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is medium, and that of available potassium is very low. If this soil has not been limed, it generally is medium acid in the surface layer. The surface layer is about 3 percent organic matter. Organic matter content in the solum amounts to about 50 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is well suited to corn, soybeans, oats, hay, and trees and as pasture. This soil is susceptible to erosion. Contour farming, conservation tillage, and terraces help to reduce erosion. If this soil is used as pasture, preventing overgrazing can reduce runoff and erosion.

This soil is suitable for building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. A more suitable base material is needed for local roads. The moderately slow permeability of this soil is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

76C2—Ladoga silt loam, 5 to 9 percent slopes, moderately eroded. This is a moderately well drained, moderately sloping soil on the edge of convex, narrow upland divides and on side slopes between waterways. The areas generally are long and narrow; they commonly are a half mile or more long.

Typically, the surface layer is mixed dark grayish brown and brown silt loam 8 inches thick. In cultivated areas, plowing has mixed subsoil material with material from the eroded surface layer and the subsurface layer. This plow layer directly overlies the subsoil. The subsoil is about 38 inches thick. In the upper part, it is brown silty clay loam that has a few yellowish brown mottles, and in the lower part it is mottled grayish brown and dark yellowish brown silty clay loam. The substratum is light

brownish gray silty clay loam that has yellowish brown mottles.

Included in mapping are small areas of Sharpsburg and Nira soils at the head of drainageways and Armstrong soils on shoulder slopes. Also included are small areas of the seasonally wet and seepy Clearfield soils in coves and a few areas of the sandy Dickinson soils.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium or rapid. The content of available phosphorus is medium and that of available potassium is very low. If this soil has not been limed, it generally is medium acid in the surface layer. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 25 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, hay, and trees and as pasture.

In general, this soil requires a higher level of management than the uneroded Ladoga soil. The main hazard is erosion caused by runoff. This soil is lower in fertility than the uneroded Ladoga soil. It commonly is cloddy when tilled, and thus seedbed preparation is more difficult. This soil is more erodible because its surface layer is in poorer physical condition. The surface crusts after a heavy rain, thus hindering seedling emergence. Returning crop residue and adding manure to the soil are necessary to maintain soil tilth and productivity. Contour farming and the use of terraces help to reduce erosion.

In managing pastureland, more fertilizer and more intensive erosion control are required than for the uneroded Ladoga soil. Preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. This soil has low strength; therefore, foundations and footings for buildings need to be designed to prevent structural damage. A more suitable base material is needed for local roads. The moderately slow permeability of this soil is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

76D—Ladoga silt loam, 9 to 14 percent slopes. This is a moderately well drained, strongly sloping soil on uplands. Slopes are convex. The areas are long and narrow and extend horizontally along hillsides and around nose slopes.

Typically, the surface layer is very dark gray silt loam about 6 inches thick. In wooded areas, a thin layer of leaf litter generally is on the surface. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is about 35 inches thick. In the upper part, it is brown silty clay loam that has a few yellowish brown mottles, and in the lower part it is mottled grayish brown and dark yellowish brown silty clay loam. The substratum is light gray or light brownish gray silty clay loam that has yellowish brown mottles. Where this soil is along drainageways, the surface layer is slightly thicker and darker than is typical. In cultivated areas, the plow layer is very dark gray and is about 8 inches thick; it is a mixture of material from the surface and subsurface layers. In some areas this soil is moderately eroded.

Included in mapping are sandy Dickinson soils in a few widely scattered areas.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is medium, and that of available potassium is very low. If this soil has not been limed, it generally is medium acid in the surface layer. The plow layer, which is 8 inches thick, is about 3 percent organic matter. Organic matter in the solum amounts to about 45 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is well suited to corn, soybeans, oats, hay, and trees and as pasture. This soil is susceptible to erosion. Contour farming, conservation tillage, and terraces help to reduce erosion. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is suitable for building site development, local roads, and onsite waste disposal. This soil has low strength; therefore, foundations and footings for buildings need to be designed to prevent structural damage. A more suitable base material is needed for local roads. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

76D2—Ladoga silt loam, 9 to 14 percent slopes, moderately eroded. This is a moderately well drained, strongly sloping soil on uplands. Slopes are convex. The areas generally are long and narrow and extend horizontally along hillsides and around nose slopes.

Typically, the surface layer is mixed dark grayish brown and brown silt loam 8 inches thick. In cultivated areas, plowing has mixed subsoil material with material from the eroded surface layer and the subsurface layer. This plow layer directly overlies the subsoil. The subsoil is about 32 inches thick. In the upper part, it is brown silty clay loam that has a few yellowish brown mottles, and in the lower part it is mottled grayish brown and dark yellowish brown silty clay loam. The substratum is light gray or light brownish gray silty clay loam that has yellowish brown mottles. In some areas where slopes are steeper, this soil is severely eroded.

Included in mapping are small areas of the seasonally wet and seepy Adair and Lamoni soils on shoulder slopes and a few small areas of Gara soils on side slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is medium, and that of available potassium is very low. If this soil has not been limed, it generally is medium acid in the surface layer. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 25 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is moderately suited to corn, soybeans, and oats. It is well suited to hay, pasture grasses, and trees. It is fairly or poorly suited to most engineering uses.

In general, this soil requires a higher level of management than the uneroded Ladoga soil. The main hazard is erosion caused by runoff. This soil is lower in fertility than the uneroded Ladoga soil. It commonly is cloddy when tilled, and thus seedbed preparation is more difficult. This soil is more erodible because its surface layer is in poorer physical condition. The surface crusts after a heavy rain, thus hindering seedling emergence. Returning crop residue and adding manure to the soil are necessary to maintain soil tilth and productivity. Contour farming and the use of terraces help to reduce erosion.

In managing pastureland, more fertilizer and more intensive erosion control are required than for the uneroded Ladoga soil. Preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. This soil has low strength; therefore, foundations and footings for buildings need to be designed to prevent structural damage. A more suitable base material is needed for local roads. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

80C—Clinton silt loam, 5 to 9 percent slopes. This is a moderately well drained, moderately sloping soil on convex ridgetops, narrow divides, and side slopes. The ridges generally adjoin the wider, less sloping divides of Ladoga soils. The areas are long and narrow.

Typically, the surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 8 inches thick. The subsoil is about 52 inches thick. In the upper part, it is dark yellowish brown silty clay loam that has gray silt coatings, and in the lower part it is yellowish brown silty clay loam that has brown and gray mottles. The substratum is yellowish brown silty clay loam that has light gray mottles. In cultivated areas, erosion has removed some surface layer material, and the plow layer is dark grayish brown silt loam. Strongly sloping, severely eroded Clinton soils are in some steeper areas.

Included in mapping are small areas of Armstrong soils on the lower part of some slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is high, and that of available potassium is very low. If this soil has not been limed, it is acid in the surface layer. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 25 tons per acre.

This soil is used mainly as pasture, cropland, and woodland. It is moderately suited to corn, soybeans, and oats. It is well suited to use as hayland, pastureland, or woodland. The main hazard is erosion caused by runoff. Contour farming, conservation tillage, and terraces help to reduce erosion. If this soil is used as pasture, preventing overgrazing can help reduce runoff and erosion.

This soil is suitable for building site development and onsite waste disposal if good design and installation procedures are used. This soil has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. A more suitable base material is needed for local roads. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

80D2—Clinton silt loam, 9 to 14 percent slopes, moderately eroded. This is a moderately well drained, strongly sloping soil on ridgetops and convex side slopes on uplands. It generally is in bands around strongly sloping side slopes, but in places it is on narrow ridge crests. The areas are long and narrow.

Typically, the surface layer is dark grayish brown silt loam. In cultivated areas, plowing has mixed subsoil material with material from the eroded surface layer and the subsurface layer. The plow layer directly overlies the subsoil. The subsoil is about 44 inches thick. In the upper part, it is dark yellowish brown silty clay loam that has gray silt coatings, and in the lower part it is yellowish brown silty clay loam that has brown and gray mottles. The substratum is yellowish brown silty clay loam that has light gray mottles. In some small areas, the Clinton soil is moderately steep.

Included in mapping are small areas of moderately eroded Armstrong and Gara soils on shoulder slopes and side slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is high, and that of available potassium is very low. If this soil has not been limed, it is acid in the surface layer. The plow layer is less than 1 percent organic matter. Organic matter in the solum amounts to about 10 tons per acre.

This soil is used mainly as pastureland, cropland, and woodland. It is moderately suited to corn, soybeans, and oats. It is well suited to use as pastureland or woodland. In many small areas, this soil is used for crops and is farmed with adjacent, less sloping soils.

In general, this soil requires a higher level of management than the less eroded Clinton soil. The main hazard is erosion caused by runoff. This soil is lower in fertility than the less eroded Clinton soil. It commonly is cloddy when tilled, and thus seedbed preparation is more difficult. The surface crusts after a heavy rain, thus hindering seedling emergence. Returning crop residue and adding manure to the soil are necessary to maintain soil tilth and productivity. Contour farming, conservation tillage, and terraces help to reduce erosion.

In managing pastureland, more fertilizer and more intensive erosion control are required than for the less eroded Clinton soil. Preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is moderately suitable for building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. A more suitable base material should be used for local roads. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

80E2—Clinton silt loam, 14 to 18 percent slopes, moderately eroded. This is a moderately well drained, moderately steep soil on ridgetops and convex side slopes on uplands. The areas are long and narrow.

Typically, the surface layer is dark grayish brown silt loam 8 inches thick. In cultivated areas, plowing has mixed subsoil material with material from the eroded surface layer and the subsurface layer. The plow layer directly overlies the subsoil. The subsoil is about 40 inches thick. In the upper part, it is dark yellowish brown silty clay loam that has gray silt coatings, and in the lower part it is yellowish brown silty clay loam that has brown and gray mottles. The substratum is yellowish brown silty clay loam that has light gray mottles. In some small areas, this soil is severely eroded.

Included in mapping are small areas of Gara soils on the steepest side slopes. Also included are small areas of Lamoni soils and of clayey, reddish, weathered glacial till material on shoulder slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is high, and that of available potassium is very low. If this soil has not been limed, it is acid in the surface layer. The plow layer is less than 1 percent organic matter. Organic matter in the solum amounts to about 8 tons per acre.

This soil is used mainly as pastureland, cropland, and woodland. It is poorly suited to corn, soybeans, and oats. It is well suited to grass, trees, and alfalfa for hay. In general, this soil requires a higher level of management than the less eroded Clinton soil. The main hazard is erosion caused by runoff. This soil is lower in fertility than the less eroded Clinton soil. It commonly is cloddy when tilled, and thus seedbed preparation is more difficult. The surface crusts after a heavy rain, thus hindering seedling emergence. Returning crop residue and adding manure to the soil are necessary to improve or maintain soil tilth and productivity. Contour farming, conservation tillage, and terraces help to reduce erosion.

In managing pastureland, more fertilizer and more intensive erosion control are required than for the less eroded Clinton soil. Preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is only moderately suited to building site development and onsite waste disposal. This soil has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. A more suitable base material should be used for local roads. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IVe.

93D2—Shelby-Adair clay loams, 9 to 14 percent slopes, moderately eroded. This map unit consists of moderately well drained and somewhat poorly drained, strongly sloping soils. These soils are on convex side slopes that are partly dissected by drainageways. They are downslope from a linear area of seepage. The areas are long and narrow and extend horizontally around hillsides and into drainageways. The Shelby soil makes up 50 to 75 percent of this unit. It is less clayey than the Adair soil and is downslope from that soil. The Adair soil makes up 20 to 30 percent of the unit. These soils are so intermingled or the areas of each soil are so small that it was not practical to separate them in mapping at the scale used.

Typically, the surface layer of the Shelby soil is very dark grayish brown clay loam about 8 inches thick. Plowing has mixed subsoil material with surface layer material. This plow layer directly overlies the more clayey subsoil. The subsoil is about 34 inches thick. In the upper part, it is dark brown or dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish brown, and dark yellowish brown, calcareous clay loam that has a few stones and pebbles. White nodules of lime are in the upper part of the substratum.

Typically, the surface layer of the Adair soil is very dark grayish brown clay loam about 8 inches thick. The subsoil is about 52 inches thick. In the upper part, it is dark brown and brown clay loam that has reddish brown mottles; in the next part, it is mixed brown and strong brown clay that has yellowish red, red, and grayish brown mottles; and in the lower part, it is brown, strong brown, and yellowish brown clay loam that has grayish

brown mottles. The substratum is mottled, multicolored clay loam that has many accumulations of soft lime.

Included in mapping are severely eroded soils in some small areas where the subsoil is exposed at the shoulder of slopes or near drains on hillsides. Also included are a few small areas of Lamoni soils near the head of drainageways. Lamoni soils, unlike Adair soils, have a grayish, clayey subsoil. These included soils make up 5 to 20 percent of this map unit.

Permeability of the Shelby soil is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high. If this soil has not been limed, it generally is acid in the surface layer.

Permeability of the Adair soil is slow, and the available water capacity is high. Runoff is medium to rapid. The content of available phosphorus and potassium is very low. If this soil has not been limed, it generally is acid in the surface layer. The average plow layer in this map unit is about 2 percent organic matter. On the average, organic matter, which is mostly in the plow layer, amounts to about 30 tons per acre.

These soils are used mainly for crops and as pasture. They are moderately suited to corn, soybeans, small grains, and trees. They are suited to grasses and legumes for hay or pasture.

If these soils are used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces are not suitable on the clayey Adair soil, but they can be used in some areas. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. The Shelby soil generally requires more nitrogen and greater production inputs than the less eroded Shelby soils to maintain a high yield and to maintain or improve tilth.

Using these soils as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

These soils are poorly suited to building site development and onsite waste disposal. Seepage and slope are limitations to the use of these soils for sewage lagoons. Permeability is a limitation to use as septic tank filter fields. The high shrink-swell potential of the Adair soil is a limitation to use as sites for roads or buildings.

Capability subclass IVe.

93E2—Shelby-Adair clay loams, 14 to 18 percent slopes, moderately eroded. This map unit consists of somewhat poorly drained to moderately well drained, moderately steep soils on convex side slopes on uplands. These soils are downslope from a linear area of seepage. In most areas, the slopes are dissected by drainageways and gullies. The areas are long and narrow and extend horizontally around hillsides and into drainageways. The Shelby soil makes up 50 to 75 percent of the map unit. It is less clayey than the Adair soil and is downslope from that soil. The Adair soil makes up 20 to 30 percent of the unit. These soils are so intermingled or the areas of each are so small that it was not practical to separate them in mapping at the scale used.

Typically, the surface layer of the Shelby soil is very dark brown clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer. This plow layer directly overlies the more clayey subsoil. The subsoil is about 33 inches thick. In the upper part, it is dark brown or dark yellowish brown clay loam, and in the lower part it is brown clay loam that has grayish brown and strong brown mottles. The substratum is mottled grayish brown, yellowish brown, and dark yellowish brown, calcareous clay loam that has a few stones and pebbles. White nodules of lime are in the upper part of the substratum.

Typically, the surface layer of the Adair soil is very dark grayish brown clay loam about 8 inches thick. The subsoil is about 52 inches thick. In the upper part, it is dark brown and brown clay loam that has reddish brown mottles; in the next part, it is mixed brown and strong brown clay that has yellowish red, red, and grayish brown mottles; and in the lower part, it is brown, strong brown, and yellowish brown clay loam that has grayish brown mottles. The substratum is mottled, multicolored clay loam that has many accumulations of soft lime.

Included in mapping are severely eroded soils in some small areas where the subsoil is exposed at the shoulder of slopes or near drains on hillsides. Also included are small areas of Gara soils on the upper part of convex side slopes and Lamoni soils near the head of drainageways. These included soils make up 5 to 20 percent of this map unit.

Permeability of the Shelby soil is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is high.

Permeability of the Adair soil is slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus and of available potassium is very low.

If these soils have not been limed, they generally are acid in the surface layer. The average plow layer in this map unit is about 2 percent organic matter. On the average, organic matter, which is mostly in the plow layer, amounts to about 25 tons per acre.

These soils are used mainly for cultivated crops and as pasture. They are moderately suited to corn, soybeans, small grains, and trees. They are suited to grasses and legumes for hay or pasture.

If these soils are used for cultivated crops, erosion can cause further damage. Conservation tillage can help to

prevent excessive soil loss. Contour farming and grassed waterways can help to prevent erosion. In most areas, terraces can be used to control erosion; however, the clayey Adair soil is not suited to terraces. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce erosion, reduce crusting, and increase water infiltration. To maintain a high yield and to maintain or improve tilth, the Shelby soil in this unit generally requires more nitrogen than less eroded Shelby soils.

Using these soils as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

These soils are poorly suited to building site development and onsite waste disposal. Seepage and slope are limitations to the use of these soils for sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to use as building sites. The high shrink-swell potential of the Adair soil is a limitation to use as sites for roads or buildings.

Capability subclass VIe.

133—Colo silty clay loam, 0 to 2 percent slopes. This is a poorly drained, nearly level soil on smooth bottom lands of the larger streams and their tributaries. The areas generally are irregular in shape and are roughly parallel to the stream channel.

Typically, the surface layer is black silty clay loam about 36 inches thick. The subsoil is about 18 inches thick. It is black silty clay loam that has a few soft, brown oxides. The substratum is very dark gray silty clay loam or clay loam and has common soft, brown and black oxides. In some areas, very dark grayish brown silty overwash several inches thick is on the surface of this soil. In a few small areas, this soil is slightly ponded and is wet most of the time.

Included in mapping are small areas of Kennebec, Ackmore, Vesser, and Zook soils on flood plains.

Permeability is moderately slow, and the available water capacity is high. Runoff is slow. The content of available phosphorus and potassium in the subsoil is medium. If this soil has not been limed, the surface layer generally is acid. In cultivated areas the plow layer, which is 8 inches thick, is 6 to 7 percent organic matter. Organic matter in this soil, to a depth of 24 inches, amounts to about 110 tons per acre.

This soil is used mainly for cultivated crops or hay. It is well suited to corn, soybeans, oats, and alfalfa hay and to use as pasture.

This soil is susceptible to flooding, and flooding is the main limitation. Drainage is poor in most areas, and in wet periods swales or surface drains are ponded because of overflow. Constructing a diversion terrace on the foot slopes above this soil and installing surface and tile drains help to reduce wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development and onsite waste disposal. The hazard of flooding, seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and diversion terraces help to reduce wetness and flooding. A more suitable base material should be used to build up local roads. Roads should be graded to shed water. The bottom of sewage lagoons needs to be sealed.

Capability subclass IIw.

133+—Colo silt loam, overwash, 0 to 2 percent slopes. This is a poorly drained, nearly level soil on bottom lands of the larger streams and their tributaries. The alluvial sediment on the surface of this soil is uniformly distributed throughout all areas. The areas are irregular in shape.

Typically, the surface layer is stratified very dark grayish brown and grayish brown silt loam alluvial sediment about 16 inches thick. Below that, the original surface layer is black silty clay loam about 14 inches thick. The subsoil is about 24 inches thick. It is black silty clay loam that has a few soft, brown oxides. The substratum is very dark gray silty clay loam or clay loam and has common soft, brown and black oxides.

Included in mapping are small areas of Ackmore and Kennebec soils on flood plains.

Permeability is moderately slow, and the available water capacity is high. Runoff is slow. The content of available phosphorus and potassium in the subsoil is medium. If this soil has not been limed, the surface layer generally is acid. The plow layer, which is 8 inches thick, is about 4 percent organic matter. Organic matter in the solum amounts to about 90 tons per acre.

This soil is used mainly for cultivated crops or hay. It is suited to corn, soybeans, oats, and hay and to use as pasture.

This soil is susceptible to flooding, and flooding is the main limitation. The accumulation of sediment on the surface results in more damage to young plants than erosion caused by overflow. In some areas farming operations are delayed because of the wetness. Surface and tile drainage help to reduce wetness. A diversion terrace can be constructed along the adjacent upland slopes to help reduce overflow and deposition. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction.

This soil is poorly suited to building site development and onsite waste disposal. The hazard of flooding, the seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and diversion terraces help

to reduce wetness and flooding. A more suitable base material should be used to build up local roads. Roads should be graded to shed water. The basin in onsite waste disposal areas should be sealed.

Capability subclass IIw.

175C2—Dickinson fine sandy loam, 5 to 9 percent slopes, moderately eroded. This is a well drained to somewhat excessively drained, moderately sloping soil on convex ridges and side slopes on uplands. This soil formed in sandy alluvial sediment that has been redeposited by wind.

Typically, the surface layer is very dark grayish brown fine sandy loam about 8 inches thick. The subsoil is about 32 inches thick. It is dark brown and brown fine sandy loam in the upper part and dark brown and very dark grayish brown loamy fine sand in the lower part. The substratum is dark yellowish brown and yellowish brown fine sand and loamy fine sand and extends to a depth of more than 60 inches.

Included in mapping are a few small areas of Lamoni and Shelby soils on side slopes and small areas of Sharpsburg soils on ridges.

Permeability is moderately rapid to rapid, and the available water capacity is low. Runoff is medium. The content of available phosphorus and potassium is very low. The surface layer is neutral, and the subsoil is slightly acid to medium acid. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 30 tons per acre.

This soil is used mainly for cultivated crops and hay. In some areas it is used as pasture. This soil is moderately suited to row crops and is well suited to hay and pasture grasses. This soil is droughty. Wind and water erosion are the main hazards. Erosion removes organic matter from this soil and thus reduces fertility and lowers the available water capacity. Keeping the soil covered with crop residue or vegetation helps to protect this soil from wind and water erosion. Conservation tillage also helps to reduce erosion.

This soil is suited to building site development and onsite waste disposal if good design and installation procedures are used; however, permeability is a limitation to the use of this soil for sewage lagoons. The erosion hazard is a limitation to road construction.

Capability subclass IIIe.

175D2—Dickinson fine sandy loam, 9 to 14 percent slopes, moderately eroded. This is a well drained to somewhat excessively drained, strongly sloping soil on convex ridges and side slopes on uplands. This soil formed in sandy alluvial sediment that has been redeposited by wind.

Typically, the surface layer is very dark grayish brown fine sandy loam about 8 inches thick. The subsoil is about 29 inches thick. It is dark brown and brown fine sandy loam in the upper part, dark brown and very dark grayish brown fine sandy loam in the next part, and dark yellowish brown loamy fine sand in the lower part. The substratum is dark yellowish brown and yellowish brown fine sand and loamy fine sand and extends to a depth of more than 60 inches.

Included in mapping are a few small areas of Lamoni and Shelby soils on side slopes and small areas of Sharpsburg soils on the ridges.

Permeability is moderately rapid to rapid, and the available water capacity is low. Runoff is medium. The content of available phosphorus and potassium is very low. The surface layer is neutral, and the subsoil is slightly acid to medium acid. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 25 tons per acre.

This soil is used mainly for cultivated crops and hay. In some areas it is used as pasture. This soil is moderately suited to row crops and is well suited to hay and pasture grasses. This soil is droughty. Wind and water erosion are the main hazards. Erosion removes organic matter from this soil and thus reduces fertility and lowers the available water capacity. Keeping the soil covered with crop residue or vegetation helps to protect this soil from wind and water erosion. Conservation tillage also helps to reduce erosion.

This soil is suited to building site development and onsite waste disposal; however, the permeability is a limitation to sewage lagoons. Erosion is a hazard in constructing local roads, and the soil needs to be protected. Reducing the length of time that the soil is left without an adequate vegetative cover and reducing the steepness and length of slopes help to control erosion.

Capability subclass IVe.

179D—Gara loam, 9 to 14 percent slopes. This is a moderately well drained to well drained, strongly sloping soil on convex side slopes and nose slopes on uplands. The areas generally are long and narrow.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown and brown loam about 3 inches thick. The subsoil is about 38 inches thick. In the upper part, it is dark yellowish brown clay loam that has strong brown and yellowish brown mottles, and in the lower part it is mainly mottled, strong brown and grayish brown clay loam. The substratum is calcareous, mottled light gray, dark yellowish brown, and brown clay loam. In cultivated areas, the plow layer is dark grayish brown loam 8 inches thick.

Included in mapping are small areas of Ladoga soils in the less sloping areas and Armstrong and Shelby soils on shoulder slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is very low or low, and that of available potassium is very low. If this soil has not been limed, the surface layer generally is acid. The surface

layer is about 2 percent organic matter. Organic matter in the solum amounts to about 40 tons per acre.

This soil is used mainly for cultivated crops and hay and as pasture. It is poorly suited to corn and soybeans. This soil is suited to small grains, grasses and legumes for hay or pasture, and trees.

If this soil is used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces can be used to control erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is moderately suited to building site development and onsite waste disposal. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IVe.

179D2—Gara loam, 9 to 14 percent slopes, moderately eroded. This is a moderately well drained to well drained, strongly sloping soil on convex side slopes and nose slopes on uplands. This soil generally is on the lower part of slopes and extends to the edge of the valley or drainageway. The areas are long and narrow. They extend horizontally along hillsides.

Typically, the surface layer is dark grayish brown and brown loam 8 inches thick. In cultivated areas, plowing has mixed material from the upper part of the subsoil with material from the eroded surface and subsurface layers. This plow layer directly overlies the subsoil. The subsoil is about 36 inches thick. In the upper part, it is dark yellowish brown clay loam that has strong brown and yellowish brown mottles, and in the lower part, it is mainly mottled, strong brown and grayish brown clay loam. The substratum is calcareous, mottled light gray, dark yellowish brown, strong brown, and brown clay loam. A soil that is similar to this Gara soil but has a more sandy subsoil and a soil that is calcareous beginning at a depth of less than 40 inches are included in mapping. In some small areas, this soil is severely eroded.

Included in mapping are small areas of Shelby loam on side slopes. Also included are some small linear-shaped areas of Armstrong soils along the shoulder of slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low or very low, and that of available potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 1 percent organic matter. Organic matter in the solum amounts to about 25 tons per acre.

This soil is used mainly for cultivated crops and hay and as pasture. It is moderately suited to corn, soybeans, and oats. It is well suited to alfalfa, hay, pasture grasses, and trees. In some areas that have been cleared, this soil is used as pasture.

If this soil is used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. In places, contour farming and terraces can be used to control erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Gara soils to maintain high yields and to maintain or improve tilth.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is moderately suited to building site development and onsite waste disposal. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope also is a limitation to use as building sites.

Capability subclass IVe.

179E2—Gara loam, 14 to 18 percent slopes, moderately eroded. This is a moderately well drained to well drained, steep soil on convex side slopes and nose slopes on uplands. This soil is on the lower part of slopes and generally extends to the edge of the valley or drainageway. The areas are long and narrow. They extend horizontally along hillsides.

Typically, the surface layer is dark grayish brown and brown loam 8 inches thick. In cultivated areas, plowing has mixed material from the upper part of the subsoil with material from the surface and subsurface layers. This plow layer directly overlies the clay loam subsoil. The subsoil is about 34 inches thick. In the upper part, it is dark yellowish brown clay loam that has strong brown and yellowish brown mottles, and in the lower part it is mainly mottled, strong brown and grayish brown clay loam. The substratum is calcareous, mottled light gray, dark yellowish brown, and brown clay loam. A soil that is similar to this Gara soil but has a more sandy subsoil and a soil that is calcareous beginning at a depth of less than 40 inches are included in mapping. In areas where slopes are steepest, this Gara soil is severely eroded.

Included in mapping are linear-shaped areas of Armstrong soils along shoulder slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of

available phosphorus is very low or low, and that of available potassium is very low.

If this soil has not been limed, the surface layer generally is acid. The plow layer is about 1 percent organic matter. Organic matter in the solum amounts to about 20 tons per acre.

This soil is used mainly for cultivated crops and hay and as pasture. It is poorly suited to corn, soybeans, and oats. It is well suited to use as hayland, pastureland, or woodland.

If this soil is used for cultivated crops, erosion can cause severe damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. In most areas contour farming and terraces can be used to control erosion; however, the moderately steep slopes make these practices difficult. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Gara soils.

Using this soil as pastureland or hayland is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

Even if good design and installation procedures are used, this soil is poorly suited to building site development and onsite waste disposal. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope also is a limitation to use as building sites.

Capability subclass VIe.

179F2—Gara loam, 18 to 25 percent slopes, moderately eroded. This is a moderately well drained to well drained, steep soil on side slopes and nose slopes on uplands. This soil is on the lower part of slopes and generally extends to the edge of the valley or drainageway. The areas are long and narrow. They extend horizontally along hillsides.

In cultivated areas, the surface layer typically is dark grayish brown and brown loam 8 inches thick. It is a mixture of material from the eroded surface and subsurface layers and material from the upper part of the subsoil. The subsoil is about 30 inches thick. In the upper part, it is dark yellowish brown clay loam that has strong brown and yellowish brown mottles, and in the lower part it is mainly mottled, strong brown and grayish brown clay loam. The substratum is calcareous, mottled light gray, dark yellowish brown, and brown clay loam. In uncultivated areas, the surface layer typically is very dark gray loam about 5 inches thick, and the subsurface layer is dark grayish brown loam about 2 inches thick. A soil that is similar to this Gara soil but is calcareous beginning at a depth of less than 30 inches is included in mapping. In areas where slopes are steepest, this Gara soil is severely eroded.

Included in mapping are small areas of Armstrong soils on shoulder slopes. Also included are small areas of limestone outcrops on some slopes above the more deeply cut streams.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is very low or low, and that of available potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 1 percent organic matter. Organic matter in the solum amounts to about 15 tons per acre.

This soil is used mainly for hay and as pasture. It is not suited to use as cropland because the slopes are steep. It is well suited to use as pasture, woodland, or wildlife habitat.

If this soil is used for cultivated crops, erosion can cause severe damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terracing are difficult because of the steep slopes. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Gara soils.

Using this soil as pastureland or hayland is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

Even if good design and installation procedures are used, this soil is poorly suited to building site development and onsite waste disposal. Slope is a limitation to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to use as building sites.

Capability subclass VIe.

192C2—Adair clay loam, 5 to 9 percent slopes, moderately eroded. This is a somewhat poorly drained to moderately well drained, moderately sloping soil on convex side slopes and some ridges on uplands. The areas generally are irregularly shaped bands or strips that extend on the contour around side slopes and nose slopes and into coves at the head of drainageways. This soil is just downslope from a linear area of seepage.

Typically, the surface layer is very dark grayish brown and brown clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer. The subsoil is about 52 inches thick. In the upper part, it is dark brown and brown clay loam that has reddish brown mottles; in the middle part, it is mixed brown and strong brown clay that has yellowish red, red, and grayish brown mottles; and in the lower part it is brown, strong

brown, and mottled yellowish brown clay loam that has grayish brown mottles. The substratum is mottled yellowish brown, strong brown, grayish brown, and light brownish gray clay loam that has many accumulations of soft lime. In some small areas, this Adair soil is not eroded (fig. 10). In areas where slopes are steepest, it is severely eroded.

Included in mapping are small areas of Nira and Sharpsburg soils on ridges and Lamoni soils on shoulder slopes.

Permeability is slow, and the available water capacity is high. Runoff is medium to rapid. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 2 percent organic matter. Organic matter, mainly in the plow layer, amounts to about 40 tons per acre.

Figure 10.—Profile of uneroded Adair clay loam on uplands. The clayey subsoil hinders farming operations in areas where the dark-colored surface layer has been eroded.

This soil is used mainly for cultivated crops and as pasture. It is moderately suited to row crops and hay and to use as pasture. The main hazards are erosion and, in wet periods, seepiness. In areas where this soil is severely eroded, it is very sticky when wet and very hard when dry. This soil commonly is cloddy when tilled, and thus seedbed preparation is more difficult and the production inputs required are greater. Contour farming, conservation tillage, and the use of interceptor tile help to reduce erosion and wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development because the shrink-swell potential is high. It is poorly suited to onsite waste disposal because permeability is slow.

Capability subclass IIIe.

192D2—Adair clay loam, 9 to 14 percent slopes, moderately eroded. This is a somewhat poorly drained to moderately well drained, strongly sloping soil on convex side slopes and some ridges on uplands. The areas generally are irregularly shaped bands or strips that extend on the contour around side slopes and nose slopes and into coves at the head of drainageways. This soil is just downslope from a linear area of seepage. In some areas, it is on the top of extended ridges.

Typically, the surface layer is very dark grayish brown and brown clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer. The subsoil is about 48 inches thick. In the upper part, it is dark brown and brown clay loam that has reddish brown mottles; in the middle part, it is mixed brown and strong brown clay that has yellowish red, red, and grayish brown mottles; and in the lower part, it is brown, strong brown, and mottled yellowish brown clay loam that has grayish brown mottles. The substratum is mottled yellowish brown, strong brown, grayish brown, and light brownish gray clay loam that has many accumulations of soft lime. A few small areas of less sloping Adair soils are included in mapping. Pebbles and gravel are on the surface in some areas. In some small areas where slopes are steepest, this Adair soil is severely eroded, and the reddish-colored subsoil is exposed.

Included in mapping are small areas of Nira and Lamoni soils on the side slopes of drainageways.

Permeability is slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The surface layer is about 2 percent organic matter. Organic matter, mainly in the plow layer, amounts to about 30 tons per acre.

This soil is poorly suited to corn, soybeans, and oats. It is moderately well suited to alfalfa and is well suited to use as pasture. This soil generally is farmed with adja-

cent, more productive soils. It commonly is cloddy when tilled, and thus seedbed preparation is difficult. Contour farming, conservation tillage, and the use of interceptor tile help to reduce erosion and wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development because the shrink-swell potential is high. It is poorly suited to onsite waste disposal because of the slow permeability and the slope.

Capability subclass IVe.

212—Kennebec silt loam, 0 to 2 percent slopes. This is a moderately well drained, nearly level soil on smooth flood plains. The areas generally are longer than they are wide and are irregular in shape. They are roughly parallel to the larger streams.

Typically, the surface layer is very dark brown silt loam about 37 inches thick. The subsurface layer is very dark grayish brown silt loam about 11 inches thick. The substratum is dark grayish brown silt loam. Small areas of a soil that is similar to this Kennebec soil but has layers of lighter colored, silty sediment are included in mapping.

Included in mapping are small areas of Colo and Ackmore soils in slightly lower positions on the landscape.

Permeability is moderate, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low, and that of available potassium is very low to low. If this soil has not been limed, the surface layer generally is slightly acid. The plow layer, which is 8 inches thick, is about 5 percent organic matter. Organic matter in the solum amounts to about 100 tons per acre.

This soil is used mainly for cultivated crops or as pasture. It is well suited to corn, soybeans, oats, alfalfa, and hay and to use as pasture. It is moderately suited to trees. In places, wetness caused by overflow in wet periods delays planting in spring; however, tile or surface drainage generally is not required. Diversion terraces on foot slopes above this soil and flood-retarding structures in the watershed help to reduce flooding in spring.

This soil is poorly suited to building site development, local roads, and onsite waste disposal. The hazard of flooding, seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and diversion terraces help to reduce wetness and flooding. A more suitable base material should be used to build up local roads. Roads should be graded to shed water. The bottom of sewage lagoons needs to be sealed.

Capability class I.

220—Nodaway silt loam, 0 to 2 percent slopes. This is a moderately well drained, nearly level soil on flood plains and creek bottoms (fig. 11). The areas extend along stream channels and are frequently flooded. Old stream channels are in this unit, and in some places the land surface is uneven.

Typically, the surface layer is very dark gray silt loam about 5 inches thick. The substratum is stratified grayish brown, very dark gray, dark gray, and black silt loam that has reddish brown and yellowish brown mottles. In cultivated areas, the plow layer is dark grayish brown silt loam about 8 inches thick. Recent deposits of fine sand or silt are on the surface in some areas.

Included in mapping are small areas of Vesser, Ackmore, Colo, and Zook soils in lower positions on the landscape.

Permeability is moderate, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low, and that of available potassium is low to very low. The surface layer generally is neutral. The plow layer is 1 to 2 percent organic matter. Organic matter in the solum amounts to about 30 tons per acre.

This soil is used mainly for cultivated crops and as pasture. If it is protected from flooding, this soil is well suited to corn, soybeans, oats, and alfalfa. It is well suited to hay and pasture grasses. It is moderately suited to trees. This soil is susceptible to flooding in wet periods. Flood-retarding structures in the watershed can help to reduce flooding.

This soil is poorly suited to building site development and onsite waste disposal because of the hazard of flooding and the high water table. The low strength of this soil is a limitation to use as sites for local roads.

Capability subclass IIw.

222C—Clarinda silty clay loam, 5 to 9 percent slopes. This is a poorly drained, moderately sloping soil on uplands. It is commonly called gumbotil. The areas are crescent-shaped and are in coves at the head of drainageways or are long, narrow, and irregular. This soil is just downslope from a linear area of seepage.

Typically, the surface layer is black silty clay loam about 13 inches thick. The subsoil is about 60 inches thick. In the upper part, it is gray silty clay that has dark yellowish brown mottles, and in the lower part it is mottled gray, dark brown, and yellowish brown clay.

Included in mapping are small areas of Clearfield soils in the less sloping areas, Lamoni soils on slopes below this Clarinda soil, and Nira soils on the higher slopes.

Permeability is very slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is very low, and that of available potassium is low. If this soil has not been limed, the surface layer generally is medium acid. In cultivated areas, the plow layer, which is 8 inches thick, is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 65 tons per acre.

This soil is used mainly as pasture or cropland. It is poorly suited to corn, soybeans, and oats. This soil gen-

Figure 11.—An area of Nodaway silt loam, 0 to 2 percent slopes, on bottom lands. Gara loam, 14 to 18 percent slopes, is on uplands in the background.

erally is farmed with adjacent, more productive soils. It is moderately suited to alfalfa and hay and to use as pasture.

This soil commonly is wet and seepy in spring and is difficult to farm. It is susceptible to erosion. The main limitation is that this soil is very sticky and seepy in wet periods and is very hard when dry. This limitation is more severe if topsoil has been removed through erosion. Contour farming and interceptor tile help to reduce wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development because the shrink-swell potential is high. It is poorly suited to onsite waste disposal because permeability is very slow.

Capability subclass IVw.

222C2—Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded. This is a poorly drained, moderately sloping soil on convex side slopes and in coves at the head of drainageways on uplands. It is commonly called gumbotil. The areas generally are long and narrow and extend on the contour around side slopes and into coves at the head of drainageways. In a few areas, this soil is on the top of slightly extended ridges. It is just downslope from a linear area of seepage.

Typically, the surface layer is very dark gray and gray silty clay loam about 8 inches thick. The subsoil is about 57 inches thick. In the upper part, it is gray silty clay that has dark yellowish brown mottles, and in the lower part it is mottled gray, dark brown, and yellowish brown clay. In some small areas where slopes are steepest, this Clarinda soil is severely eroded.

Included in mapping are small areas of Clearfield and Nira soils in the less sloping areas.

Permeability is very slow, and the available water capacity is high. Runoff is medium or rapid. The content of available phosphorus is very low, and that of available potassium is low. If this soil has not been limed, the surface layer generally is medium acid. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 30 tons per acre.

This soil is used mainly as pasture or cropland. It is poorly suited to corn, soybeans, and oats. It is moderately suited to alfalfa. It is well suited to grass for hay and pasture. The main limitation is that this soil is very sticky and seepy in wet periods and is very hard when dry. This limitation is more severe if topsoil has been removed through erosion. Contour farming and interceptor tile help to reduce wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development because the shrink-swell potential is high. It is poorly suited to onsite waste disposal because permeability is very slow.

Capability subclass IVw.

222D2—Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded. This is a poorly drained, strongly sloping soil on uplands. It is commonly called gumbotil. The areas generally are long and narrow and extend on the contour along side slopes and into coves at the head of drainageways. This soil is just downslope from a linear area of seepage.

Typically, the surface layer is very dark gray and gray silty clay loam about 8 inches thick. The subsoil is about 54 inches thick. In the upper part, it is gray silty clay that has dark yellowish brown mottles, and in the lower part it is mottled gray, dark brown, and yellowish brown clay. In some small areas where slopes are steepest, this Clarinda soil is severely eroded.

Included in mapping are small areas of Lamoni soils on shoulder slopes.

Permeability is very slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is very low, and that of available potassium is low. If this soil has not been limed, the surface layer generally is medium acid.

The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 25 tons per acre.

Because this soil is in small areas that are adjacent to more productive soils, it commonly is used for row crops. It is poorly suited to corn, soybeans, and oats. It is well suited to grass for hay and to use as meadow or pasture. This soil commonly is seepy and sticky in wet periods and is very hard when dry; as a result, it is difficult to farm. Contour farming and interceptor tile help to reduce wetness. Adding organic matter to the plow layer can improve tilth. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development because the shrink-swell potential is high. It is poorly suited to onsite waste disposal because of the very slow permeability and the slope.

Capability subclass IVe.

269—Humeston silt loam, 0 to 2 percent slopes. This is a poorly drained or very poorly drained, nearly level soil in flat or slightly concave slack-water areas on bottom lands. The areas generally are long and narrow. They are along the edge of valleys and are roughly parallel to the stream channel.

Typically, the surface layer is very dark gray silt loam about 24 inches thick. The subsurface layer is dark gray and very dark gray silt loam about 8 inches thick. The subsoil is about 35 inches thick. In the upper part, it is black silty clay loam, and in the lower part it is very dark gray and dark gray silty clay loam that has brown mottles.

Included in mapping are small areas of Colo, Ackmore, Vesser, and Zook soils. Ackmore and Colo soils are near the channel. Zook and Vesser soils are on slightly higher lying bottom lands.

Permeability is moderate or moderately slow in the surface layer, and it is very slow in the subsoil. Runoff is slow or ponded. The available water capacity is high. The content of available phosphorus is medium to low, and that of available potassium is very low. The surface layer generally is acid. The plow layer, which is 8 inches thick, is 3 to 4 percent organic matter. Organic matter in the surface layer, to a depth of 24 inches, amounts to about 70 tons per acre.

This soil is used mainly for cultivated crops and as pasture. If surface drainage is adequate, this soil is moderately suited to corn, soybeans, oats, and alfalfa. It is well suited to use as pasture.

This soil is susceptible to flooding and has a fluctuating water table. Water commonly is ponded in wet periods. During dry periods in summer, the soil moisture available for crops may be insufficient. Wetness and the hazard of flooding are the main limitations to crops. Surface and tile drainage and diversion terraces constructed along adjacent foot slopes above this soil help to reduce wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction.

This soil is poorly suited to building site development and onsite waste disposal. The hazard of flooding, seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and diversion terraces help to reduce wetness and flooding. A more suitable base material should be used to build up local roads. Roads should be graded to shed water.

Capability subclass IIIw.

273B—Olmitz loam, 2 to 5 percent slopes. This is a moderately well drained or well drained, gently sloping soil on slightly concave or plane alluvial fans and foot slopes. This soil is in valleys adjacent to sloping uplands where the soils formed in glacial till or eolian sand.

Typically, the surface layer is black loam 8 inches thick. The subsurface layer is about 22 inches thick. It is black loam in the upper part and very dark grayish brown and very dark brown clay loam in the lower part. The subsoil is dark brown and brown clay loam about 42 inches thick. In some areas there are recent deposits of dark brown loamy material, 5 to 12 inches thick, on the surface. This material generally is lighter in color and lower in organic matter content than the typical surface layer material.

Included in mapping are small areas of Arbor and Shelby soils in the higher, more convex positions on the landscape.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 100 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is well suited to corn, soybeans, oats, and hay, to use as pasture, and to trees. The main hazards are the flooding of brief duration and the accumulation of loamy sediment from soils upslope. Contour farming, conservation tillage, and diversion terraces constructed on foot slopes above this soil can help to reduce flooding. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is moderately suited to building site development and onsite waste disposal. The runoff from adjacent higher slopes, high organic matter content, fair soil strength, and moderately slow permeability are limitations to the use of this soil as sites for buildings and local roads and for onsite waste disposal.

Capability subclass IIe.

273C—Olmitz loam, 5 to 9 percent slopes. This is a moderately well drained or well drained, moderately sloping soil on slightly concave or plane alluvial fans and foot slopes. The areas commonly are fan-shaped or are long and narrow. This soil is in valleys adjacent to sloping soils that formed in glacial till or eolian sand.

Typically, the surface layer is black loam 8 inches thick. The subsurface layer is about 16 inches thick. It is black loam in the upper part and very dark grayish brown and very dark brown clay loam in the lower part. The subsoil is dark brown and brown clay loam about 24 inches thick. Lighter colored, loamy outwash material 7 to 18 inches thick is on the surface in some areas on the lower part of foot slopes or on alluvial fans. This material generally is lower in organic matter content and has poorer tilth than the surface layer of this Olmitz soil.

Included in mapping are small areas of Gara, Shelby, and Caleb soils on the steeper slopes.

Permeability is moderate, and the available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 100 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is well suited to corn, soybeans, oats, and hay, to use as pasture, and to trees. This soil is susceptible to erosion; however, the soil lost through erosion is replaced by loamy sediment from soils upslope. The main hazard is the accumulation of loamy sediment from the soils upslope. Contour farming and diversion terraces constructed on the foot slopes above this soil can help to reduce sedimentation. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is moderately suited to building site development and onsite waste disposal. The runoff from adjacent higher slopes, high organic matter content, fair soil strength, and moderately slow permeability are limitations to the use of this soil as sites for buildings and local roads and for onsite waste disposal.

Capability subclass IIIe.

287B—Zook-Colo-Ely silty clay loams, 2 to 5 percent slopes. This map unit consists of somewhat poorly drained and poorly drained soils in drainageways and on creek bottoms. The areas generally are long and narrow. This unit is about 40 percent Zook soil, 20 percent Colo soil, and 20 percent Ely soil. These soils are so intermingled or the areas of each are so small that it was not practical to separate them in mapping at the scale used.

Typically, the surface layer of the Zook soil is black silty clay loam about 30 inches thick. The subsoil is about 34 inches thick. It is very dark gray silty clay in the upper part and dark gray and very dark gray silty clay loam in the lower part.

Typically, the surface layer of the Colo soil is black silty clay loam about 36 inches thick. The subsoil is about 18 inches thick. It is black silty clay loam that has a few soft, brown oxides.

Typically, the surface layer of the Ely soil is very dark brown, black, and very dark gray silty clay loam about 22 inches thick. The subsoil is about 44 inches thick. In the upper part, it is very dark grayish brown and dark grayish brown, friable silty clay loam that has a few dark yellowish brown mottles; in the lower part, it is dark grayish brown, mottled silty clay loam.

Included in mapping and making up about 20 percent of the unit are small areas of Ackmore and Judson soils. Judson soils are on foot slopes and fans. Ackmore soils are adjacent to drainageways on lower lying bottom lands.

Permeability of the Zook soil is slow. The available water capacity is high. Runoff is slow. The content of available phosphorus and potassium is low.

Permeability of the Colo soil is moderately slow. The available water capacity is high. Runoff is slow. The content of available phosphorus and potassium in the subsoil is medium.

Permeability of the Ely soil is moderate. The available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is very low.

If these soils have not been limed, the surface layer generally is acid. The average plow layer in this map unit, which is 8 inches thick, is about 5 percent organic matter. On the average, organic matter in the surface layer, to a depth of 24 inches, amounts to about 110 tons per acre.

These soils are used mainly for cultivated crops and as pasture. They are well suited to corn, soybeans, oats, alfalfa, and grass for hay or pasture. They are poorly suited to trees.

These soils are susceptible to overflow in spring. The wetness of the Zook soil creates some problems associated with farming, but tile drains on the Zook and Colo soils and a diversion terrace along the base of adjacent upland slopes can help to reduce overflow and wetness. If these soils are used as pasture, preventing overgrazing and deferring grazing when the soils are very wet can reduce surface compaction and runoff.

These soils are poorly suited to building site development and onsite waste disposal because of wetness, the hazard of flooding, and the high shrink-swell potential of the Zook soil.

Capability subclass IIw.

315—Nodaway soils, frequently flooded, 0 to 2 percent slopes. These are moderately well drained, nearly level soils on flood plains and creek bottoms of gently undulating bottom lands. They are frequently flooded. The areas are irregular in shape and extend along the channel of the larger streams. Most areas have an undulating surface that is subject to change through deposition from overflow. The undulations are irregular in size and shape but commonly are roughly parallel to the stream channel. This map unit is about 60 percent Nodaway silt loam, 20 percent stratified sand and silt, 10 percent Ackmore silt loam, and 10 percent Colo silt loam.

Typically, the surface layer of the Nodaway soils is very dark gray silt loam about 5 inches thick. The substratum is more than 40 inches thick. It is stratified grayish brown, very dark gray, dark gray, and black silt loam that has reddish brown mottles. In cultivated areas, the plow layer is dark gray silt loam about 8 inches thick.

The alluvium in this unit varies in composition but typically is unconsolidated, stratified brown and grayish brown sandy and silty sediment to a depth of more than 40 inches.

Included in mapping are small areas of Ackmore and Colo soils in the slightly lower lying stream channels.

Permeability is moderate, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low, and that of available potassium is low to very low. The surface layer generally is neutral. In cultivated areas, the plow layer generally is less than 1 percent organic matter. Organic matter in the solum amounts to about 15 tons per acre.

These soils are not suited to crops unless they are protected from flooding. If they are protected from flooding, these soils are poorly suited to corn, soybeans, or oats, and they are moderately suited to alfalfa. Farming operations are delayed in wet periods. These soils generally are used and are suited to use as pasture. They are naturally wet and generally are wooded. Except for cottonwood, these soils are poorly suited to trees.

These soils are frequently flooded, and the water table is high in wet periods. Properly placed dikes and a diversion terrace constructed along the base of adjacent upland slopes help to reduce flooding and wetness. Preventing overgrazing and deferring grazing when the soil is very wet reduce surface compaction.

These soils are poorly suited to building site development and onsite waste disposal because of the frequent flooding and the high water table.

Capability subclass IVw.

368—Macksburg silty clay loam, 0 to 2 percent slopes. This is a somewhat poorly drained, nearly level soil on smooth, moderately wide to wide divides on uplands. The areas generally are longer than they are wide and have irregular boundaries.

Typically, the surface layer and subsurface layer are black silty clay loam about 20 inches thick. The subsoil is about 40 inches thick. In the upper part, it is dark grayish brown and brown silty clay loam, and in the lower part it is olive gray silty clay loam that has brownish mottles. The substratum is olive gray silty clay loam that has brownish mottles. A soil that is similar to this Macksburg soil but is poorly drained and has a lighter colored subsurface layer is in a few small wet spots and in slight upland depressions.

Included in mapping are small areas of Winterset soils in level areas and Sharpsburg soils in the more sloping areas.

Permeability is moderately slow, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, the surface layer generally is acid. The plow layer, which is 8

inches thick, is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 90 tons per acre.

This soil is used mainly for cultivated crops (fig. 12). It is well suited to corn, soybeans, oats, hay, and trees and to use as pasture.

This soil is susceptible to temporary, shallow ponding in wet periods. Adequate drainage helps to reduce wetness, improve aeration, and provide a deep root zone for plants. Tile drainage generally is effective but is not always needed. Returning crop residue to the soil and deferring tillage when the soil is wet help to maintain good tilth. If this soil is used as pastureland, overgrazing or grazing when the soil is wet can cause surface compaction.

This soil is poorly suited to building site development because the seasonal water table and the shrink-swell potential are high. It is poorly suited to onsite waste disposal because of the seasonal high water table and the moderately slow permeability.

Capability class I.

368B—Macksburg silty clay loam, 2 to 5 percent slopes. This is a somewhat poorly drained, gently sloping soil on moderately wide to wide upland divides. This soil is on smooth, slightly convex slopes along the edge of broad divides and in slightly concave areas near the head of drainageways. The areas generally are long and narrow.

Typically, the surface and subsurface layers are black silty clay loam about 20 inches thick. The subsoil is about 40 inches thick. In the upper part, it is dark grayish brown and brown silty clay loam, and in the lower part it is olive gray silty clay loam that has brownish mottles. The substratum is olive gray silty clay loam that has brownish mottles.

Included in mapping are small areas of Nira and Sharpsburg soils on convex slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, the surface layer generally is acid. In cultivated areas, the plow layer, which is 8 inches thick, is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 85 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, grass and alfalfa hay, and trees and to use as pasture. This soil is susceptible to erosion. In places, drainage is needed to insure that farming operations are timely. If it is needed, tile drainage generally is effective. Constructing terraces on the long slopes helps to reduce erosion. Returning crop residue to the soil and deferring tillage when the soil is wet help to maintain good tilth. If this soil is used as pastureland, overgrazing or grazing when the soil is wet can cause surface compaction and impede runoff from the pasture.

This soil is poorly suited to building site development because the seasonal water table and the shrink-swell potential are high. It is poorly suited to onsite waste

Figure 12.—Landscape of Macksburg silty clay loam, 0 to 2 percent slopes. Bales of alfalfa are in the foreground, and a cornfield is in the background.

disposal because of the seasonal high water table and the moderately slow permeability.

Capability subclass IIe.

369—Winterset silty clay loam, 0 to 2 percent slopes. This is a poorly drained, nearly level soil on broad, flat divides on uplands. The areas generally are longer than they are wide and have irregular boundaries.

Typically, the surface layer is black silty clay loam about 16 inches thick. The subsoil is about 45 inches thick. In the upper part, it is very dark gray silty clay loam; in the middle part, it is dark gray silty clay that has yellowish brown mottles; and in the lower part, it is gray and grayish brown silty clay loam that has yellowish brown mottles. The substratum is gray silty clay loam that has yellowish brown mottles. In some very small areas in slight depressions, this soil is wetter than is typical.

Included in mapping are small areas of Macksburg soils in the more sloping areas.

Permeability is moderately slow or slow, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low to medium, and that of available potassium is medium. If this soil has not been limed, the surface layer generally is acid. The plow layer, which is 8 inches thick, is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 100 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, alfalfa, grass, and hay and to use as pasture. It is poorly suited to trees. Adequate drainage is needed to reduce wetness, improve aeration, and provide a deep root zone for plants. Tile drainage generally is effective. Returning crop residue to the soil and deferring tillage when the soil is wet help to maintain good tilth. If this soil is used as pastureland, overgrazing or grazing when the soil is wet can cause surface compaction and poor tilth.

This soil is poorly suited to building site development because the seasonal water table and the shrink-swell potential are high. It is poorly suited to onsite waste disposal because of the seasonal high water table and the moderately slow or slow permeability.

Capability subclass IIw.

370—Sharpsburg silty clay loam, 0 to 2 percent slopes. This is a moderately well drained, nearly level soil on upland ridges. The areas generally are long and narrow and are along the middle of upland divides.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark grayish brown silty clay loam about 12 inches thick. The subsoil is about 29 inches thick. In the upper part, it is brown silty clay loam, and in the lower part, it is mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam. The substratum is light brownish gray silty clay loam that has strong brown mottles. Included in mapping are small areas of Macksburg soils in the level areas.

Permeability is moderately slow, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, it generally is slightly acid or medium acid. The plow layer is about 4 percent organic matter. Organic matter in the solum amounts to about 85 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, alfalfa and grass for hay, and trees and to use as pasture. If this soil is used for cultivated crops, returning crop residue to the soil or adding other organic material helps to maintain fertility, prevent soil erosion, reduce crusting, and increase water infiltration.

This soil is used as pasture in areas adjacent to less productive soils or near a farmstead. Overgrazing can cause surface compaction and can reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is moderately suited to building site development and onsite waste disposal. This soil has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. A more suitable base material is needed for local roads. Permeability is a limitation to the use of this soil as septic tank filter fields.

Capability class I.

370B—Sharpsburg silty clay loam, 2 to 5 percent slopes. This is a moderately well drained, gently sloping soil on convex ridges and side slopes on uplands. This soil generally is on upland divides and between waterways. It is upslope from a linear area of seepage. The areas generally are long and narrow.

Typically, the surface layer is black silty clay loam about 9 inches thick (fig. 13). The subsurface layer is black and very dark grayish brown silty clay loam about 12 inches thick. The subsoil is about 29 inches thick. It is brown silty clay loam in the upper part and mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles.

Included in mapping are small areas of Macksburg soils in the more level areas and Nira soils at the head of drainageways.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, it generally is slightly acid or medium acid. The plow layer is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 85 tons per acre.

This soil is used mainly for cultivated crops (fig. 14). It is suited to corn, soybeans, oats, grass and alfalfa hay, and trees and to use as pasture. Conservation tillage, contour farming (fig. 15), and terraces on long slopes can help to reduce erosion. If this soil is used as pasture, preventing overgrazing and deferring grazing when

Figure 13.—Profile of Sharpsburg silty clay loam on uplands.

the soil is very wet can reduce surface compaction and runoff.

This soil is suitable for building site development, local roads, and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Permeability is a limitation to the use of this soil as septic tank filter fields.

Capability subclass IIe.

370C—Sharpsburg silty clay loam, 5 to 9 percent slopes. This is a moderately well drained, moderately sloping soil on convex ridges and side slopes on uplands. It generally is on the edge of upland divides and between waterways. It is upslope from a linear area of seepage. The areas generally are long and narrow.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 28 inches thick. It is brown silty clay loam in the upper part and mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles. In some small areas the Sharpsburg soil is more eroded than this soil and in some areas it is gently sloping.

Included in mapping are small areas of poorly drained Clearfield soils near the lower boundary of the unit and in small, concave, bowl-shaped areas near upland waterways.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, it generally is slightly acid or medium acid. The plow layer is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 80 tons per acre.

This soil is used mainly for cultivated crops. It is suited to corn, soybeans, small grains, and grasses and legumes grown for hay or pasture.

If this soil is used for cultivated crops, erosion is a hazard. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces can be used to control erosion. Returning crop residue or adding other organic material to the soil helps to maintain fertility, reduce soil erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is moderately suited to building site development and onsite waste disposal. This soil has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

Figure 14.—Sharpsburg silty clay loam, 2 to 5 percent slopes, in a plowed field. A field of corn is in the background.

Figure 15.—Contour stripcropping in an area of Sharpsburg silty clay loam, 2 to 5 percent slopes, and Shelby clay loam, 9 to 14 percent slopes.

370C2—Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded. This is a moderately well drained, moderately sloping soil on convex ridges and side slopes on uplands. It generally is on the edge of upland divides and between waterways. This soil is upslope from a linear area of seepage. The areas generally are long and narrow.

Typically, the surface layer is mixed very dark grayish brown and dark yellowish brown silty clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer. This plow layer directly overlies the more clayey subsoil. The subsoil is about 26 inches thick. It is brown silty clay loam in the upper part and mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles. In some small areas on side slopes and nose slopes, the Sharpsburg soil is severely eroded.

Included in mapping are small areas of Nira soils at the head of drainageways, Ladoga soils on the steeper slopes, and poorly drained Clearfield soils in the lower lying areas.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, it generally is slightly acid or medium acid. The plow layer is about 2 percent organic matter. Organic matter in this soil, mainly in the plow layer, amounts to about 40 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, grass and alfalfa hay, and trees and to use as pasture. In general, this soil requires a higher level of management than the less eroded Sharpsburg soil. The main hazard is erosion caused by runoff. This soil is lower in fertility than the less eroded Sharpsburg soil. It commonly is cloddy when tilled, and

thus seedbed preparation is more difficult. This soil is more erodible because its surface layer is in poorer physical condition. The surface crusts after a heavy rain, thus hindering seedling emergence. Returning crop residue and adding manure to the soil are necessary to improve or maintain soil tilth and productivity. Contour farming, conservation tillage, and terraces help to reduce erosion. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet reduces surface compaction and runoff.

This soil is moderately suited to building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

370D—Sharpsburg silty clay loam, 9 to 14 percent slopes. This is a moderately well drained, strongly sloping soil on convex ridges and side slopes on uplands. It generally is on the edge of upland divides. The areas generally are long and narrow. They are roughly parallel to the contour and extend around hillsides and into upland drainageways.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown silty clay loam about 6 inches thick. The subsoil is about 26 inches thick. It is brown silty clay loam in the upper part and mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles. In some small areas the Sharpsburg soil is moderately eroded, and in some areas it is moderately sloping.

Included in mapping are small areas of Ladoga soils on the steeper slopes and small areas of poorly drained Clearfield soils near the lower boundary of the unit and in small, concave, bowl-shaped areas near upland waterways.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, it generally is slightly acid or medium acid. The plow layer is about 3 percent organic matter. Organic matter in the solum amounts to about 75 tons per acre.

This soil is used mainly for cultivated crops. It is suited to corn, soybeans, small grains, grasses and legumes for hay or pasture, and trees. If this soil is used for cultivated crops, erosion is a hazard. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces can be used to control erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is poorly suited to building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to sewage lagoons.

Capability subclass IIIe.

370D2—Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded. This is a moderately well drained, strongly sloping soil on convex ridges and side slopes on uplands. It generally is on the edge of upland divides. The areas generally are long and narrow. They are roughly parallel to the contour and extend around hillsides and into upland drainageways.

Typically, the surface layer is mixed very dark grayish brown and dark yellowish brown silty clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer. This plow layer directly overlies the more clayey subsoil. The subsoil is about 24 inches thick. It is brown silty clay loam in the upper part and mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles. In some small areas where slopes are steeper, the Sharpsburg soil is severely eroded.

Included in mapping are small areas of Ladoga soils on the steeper slopes, Lamoni and Adair soils on shoulder slopes, and Shelby soils on side slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, it generally is slightly acid or medium acid. The plow layer is about 2 percent organic matter. Organic matter in this soil, mainly in the plow layer, amounts to about 35 tons per acre.

This soil is used mainly for cultivated crops. It is suited to corn, soybeans, small grains, and grasses and legumes for hay or pasture.

If this soil is used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces can be used to control erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Sharpsburg soils to maintain high yields and to maintain or improve tilth.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can

cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is poorly suited to building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to sewage lagoons.

Capability subclass IIIe.

412G—Sogn soils, 25 to 40 percent slopes. These are shallow, somewhat excessively drained, very steep soils on uplands adjacent to valleys of the Middle River. These soils formed in a thin layer of material overlying limestone bedrock. The areas are long and narrow. They commonly are less than 150 feet wide. A few outcrops of limestone bedrock that are less than 50 feet wide are scattered throughout this map unit.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer consists mainly of limestone fragments about 7 inches thick; some silty clay loam soil material is in the cracks and crevices. Hard limestone bedrock is below a depth of 16 inches.

Included in mapping are small areas of Clinton and Gara soils in areas where slopes are less steep.

Permeability is moderate, and the available water capacity is very low. Runoff is rapid. The content of available phosphorus and potassium is very low. These soils generally are neutral or calcareous. The surface layer is about 3 percent organic matter. Organic matter in the solum amounts to about 20 tons per acre.

These soils are not suitable for cultivation. They are suited to use as pasture, woodland, or wildlife habitat. Erosion is a severe hazard unless these soils are properly managed. These soils need to be protected against overgrazing. A protective vegetative cover needs to be maintained.

These soils are poorly suited to building site development and onsite waste disposal because they are shallow to bedrock and are very steep.

Capability subclass VIIs.

428B—Ely silty clay loam, 2 to 5 percent slopes. This is a somewhat poorly drained soil on slightly concave or smooth foot slopes and alluvial fans along the edge of valleys. The areas generally are long and narrow and are roughly parallel to the stream.

Typically, the surface layer is very dark brown silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray silty clay loam about 14 inches thick. The subsoil is about 44 inches thick. It is dark grayish brown silty clay loam that has dark yellowish brown, yellowish brown, and dark gray mottles. In some areas this soil has slopes of 5 to 9 percent.

Included in mapping are small areas of Colo and Ackmore soils on bottom lands and Judson soils on foot slopes.

Permeability is moderate, and the available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is 4 to 5 percent organic matter. Organic matter in the solum amounts to about 100 tons per acre.

This soil is used mainly for cultivated crops and hay. It is suited to corn, soybeans, oats, grass and alfalfa hay, and trees and to use as pasture.

This soil is susceptible to erosion. Wetness caused by runoff from soils upslope is a limitation in some places. Contour farming, conservation tillage, and a diversion terrace constructed along the base of adjacent upland slopes can help to reduce erosion and wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when this soil is very wet can reduce surface compaction. Interceptor tile is needed in some places to reduce wetness.

This soil is poorly suited to building site development and onsite waste disposal. The hazard of flooding, seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses.

Capability subclass IIe.

430—Ackmore silty clay loam, 0 to 2 percent slopes. This is a somewhat poorly drained, nearly level soil on bottom lands. The areas of this soil in the smaller valleys generally are long and narrow, and on the larger bottom lands they are irregular. They generally are along or are roughly parallel to stream channels.

Typically, the surface layer is black silty clay loam about 10 inches thick. The substratum is dark-colored, stratified silty clay loam and silt loam about 15 inches thick. A firm, fine textured buried soil about 55 inches thick is at a depth of about 25 inches. It is black silty clay loam in the upper part and very dark gray silty clay loam in the lower part. The substratum of the buried soil is stratified very dark gray and gray silty clay loam. In cultivated areas, the plow layer is very dark brown and silty.

Included in mapping are small areas of Nodaway, Colo, and Zook soils on flood plains.

Permeability is moderately slow, and the available water capacity is high. Runoff is slow. The content of available phosphorus is low, and that of available potassium is very low. If this soil has not been limed, it generally is slightly acid. The plow layer is 3 to 4 percent organic matter. Organic matter in this soil, to a depth of 24 inches, amounts to about 90 tons per acre.

This soil is used mainly for crops and as pasture. If it is protected from overflow and if adequate drainage is

provided, this soil is well suited to corn, soybeans, oats, and grass and alfalfa hay and to use as pasture. In spring, wetness caused by overflow is a limitation unless this soil is protected. The main hazards to crops are the seasonal flooding and wetness. Tile drainage and a diversion terrace constructed along the base of adjacent upland slopes help to reduce wetness. If this soil is used as pasture, preventing overgrazing and deferring grazing when this soil is very wet can reduce surface compaction.

This soil is poorly suited to building site development and onsite waste disposal. The hazard of flooding, seasonal high water table, high organic matter content, low strength, and frost action are severe limitations to these uses. Artificial drainage and diversion terraces help to reduce wetness and flooding. A more suitable base material should be used to build up local roads. Roads should be graded to shed water. The bottom of sewage lagoons needs to be sealed.

Capability subclass IIw.

434D—Arbor loam, 9 to 14 percent slopes. This is a well drained and moderately well drained, strongly sloping soil on slightly concave to plane foot slopes on uplands. The areas generally are small in size and irregular in shape.

Typically, the surface layer is very dark brown loam about 6 inches thick. The subsurface layer is very dark brown loam about 12 inches thick. The subsoil is brown clay loam about 26 inches thick. The substratum is brown and yellowish brown clay loam that has grayish brown and strong brown mottles. In some small areas, this soil is moderately eroded.

Included in mapping are small areas of Shelby and Olmitz soils on the steeper slopes.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium to rapid. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, the surface layer generally is acid. In cultivated areas, the plow layer is about 3 percent organic matter. Organic matter in the solum amounts to about 75 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, and alfalfa and grass for hay or to use as pasture. It is well suited to trees. Erosion is the main hazard. Contour farming, terraces, grassed waterways, and conservation tillage can help to reduce runoff and erosion. If this soil is used as pasture, preventing overgrazing can help to reduce runoff and erosion.

This soil is suitable for building site development and onsite waste disposal. Slope is a limitation to the use of this soil for sewage lagoons, as septic tank filter fields, and as building sites.

Capability subclass IIIe.

451D2—Caleb loam, 9 to 14 percent slopes, moderately eroded. This is a moderately well drained, strongly sloping soil on low, stepped upland ridges just upslope from the bottom lands. In some places this soil is along the lower part of side slopes and on small foot slopes that extend along the edge of valleys. The areas are long and narrow.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsoil is about 42 inches thick. In the upper part, it is dark yellowish brown clay loam, and in the lower part it is stratified yellowish brown and pale brown clay loam, sandy clay loam, sandy loam, and loamy sand. The substratum, to a depth of more than 60 inches, is stratified yellowish brown and brown clay loam, sandy clay loam, sandy loam, and loamy sand.

Included in mapping are small areas of Gara loam on the more convex side slopes.

Permeability is variable. The available water capacity is medium. Runoff is rapid. The content of available phosphorus and potassium in the subsoil is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is 1 to 3 percent organic matter. Organic matter in the solum amounts to about 25 tons per acre.

This soil is used mainly for cultivated crops and hay. It is poorly suited to corn, soybeans, and oats. It is well suited to alfalfa or grass grown for hay and to use as pasture. It is well suited to trees. In general, this soil requires a higher level of management than the less eroded Caleb soil. The main hazard is erosion caused by runoff. This soil is lower in fertility than the less eroded Caleb soil. It commonly is droughty, and thus seedbed preparation is difficult. Interceptor tile in some places and terraces on adjacent upland slopes help to reduce erosion. Returning crop residue and adding manure to the soil are necessary to maintain soil tilth and productivity. In managing pastureland, adding fertilizer and preventing overgrazing are needed to control erosion.

This soil is suitable for building site development. It is poorly suited to onsite waste disposal. Slope and permeability are limitations to the use of this soil as septic tank filter fields and sewage lagoons.

Capability subclass IVe.

570B—Nira silty clay loam, 2 to 5 percent slopes. This is a moderately well drained, gently sloping soil on short convex slopes on uplands. The areas generally are long, narrow, and irregular. They are around the head of waterways and on side slopes between waterways. This soil is just upslope from a linear area of seepage.

Typically, the surface layer is very dark gray silty clay loam about 10 inches thick. The subsoil is about 36 inches thick. In the upper part, it is brown silty clay loam; in the next part, it is mottled grayish brown and strong brown silty clay loam; and in the lower part, it is light gray and light olive gray silty clay loam that has many

strong brown and yellowish red mottles. The substratum is light gray silty clay loam that has strong brown and yellowish red mottles. It overlies clayey, grayish-colored gumbotil, which begins at a depth of 4 to 8 feet. In cultivated areas, the plow layer is mixed very dark gray and very dark grayish brown silty clay loam.

Included in mapping are small areas of the more poorly drained Clearfield and Macksburg soils near the lower boundary of the unit and in small, concave, bowl-shaped areas near upland waterways. Also included are small areas of Sharpsburg soils that are more eroded than this soil.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is 3 to 4 percent organic matter. Organic matter in the solum amounts to about 80 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is suited to corn, soybeans, small grains, grasses and legumes for hay or pasture, and trees.

If this soil is used for cultivated crops, erosion is a hazard. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces can be used to control erosion. In places, interceptor tile needs to be installed to control seepage. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is moderately suited to building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIe.

570C—Nira silty clay loam, 5 to 9 percent slopes. This is a moderately well drained, moderately sloping soil on plane or short convex slopes on uplands. It commonly is at the head of waterways (fig. 16) and on side slopes between waterways. This soil is just upslope from a linear area of seepage. The areas generally are long and narrow.

Typically, the surface layer is very dark gray silty clay loam about 10 inches thick. The subsoil is about 32 inches thick. In the upper part, it is brown silty clay loam; in the next part, it is mottled grayish brown and strong brown silty clay loam; and in the lower part, it is light gray and light olive gray silty clay loam that has many strong brown and yellowish red mottles. The substratum is light gray silty clay loam that has strong brown and yellowish red mottles. It overlies clayey, grayish-colored gumbotil beginning at a depth of 4 to 8 feet. In cultivated areas, the plow layer is very dark gray and very dark grayish brown silt loam.

Included in mapping are small areas of poorly drained Clearfield soils near the lower boundary of the unit and in small, concave, bowl-shaped areas near upland waterways. Also included are small areas of Sharpsburg and Ladoga soils that are more eroded than this soil and that are gently sloping.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 3 percent organic matter. Organic matter in the solum amounts to about 75 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is suited to corn, soybeans, small grains, grasses and legumes for hay or pasture, and trees.

If this soil is used for cultivated crops, erosion is a hazard. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces can be used to control erosion. In places, interceptor tile needs to be installed to control seepage. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is moderately suited to building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

570C2—Nira silty clay loam, 5 to 9 percent slopes, moderately eroded. This is a moderately well drained, moderately sloping soil on plane or short convex slopes on uplands. It commonly is at the head of waterways and on side slopes between waterways. This soil is just upslope from a linear area of seepage. The areas generally are long and narrow.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. Plowing has mixed

Figure 16.—Hayfield in an area of Nira silty clay loam, 5 to 9 percent slopes, at the upper end of a drainageway on uplands.

some subsoil material into the surface layer. This plow layer directly overlies the subsoil. The subsoil is about 30 inches thick. In the upper part, it is brown silty clay loam; in the next part, it is mottled grayish brown and strong brown silty clay loam; and in the lower part, it is light gray and light olive gray silty clay loam that has many strong brown and yellowish red mottles. The substratum is light gray silty clay loam that has strong brown and yellowish red mottles. It overlies clayey, grayish-colored gumbotil beginning at a depth of 4 to 8 feet. In some small areas on side slopes and nose slopes, this Nira soil is severely eroded.

Included in mapping are small areas of Sharpsburg and Ladoga soils on the steeper slopes and areas of poorly drained Clearfield and Clarinda soils.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 2 percent organic matter. Organic matter in this soil, mainly in the plow layer, amounts to about 40 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is suited to corn, soybeans, small grains, grasses and legumes for hay or pasture, and trees.

If this soil is used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces can be used to control erosion. In places, interceptor tile needs to be installed to control seepage. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Nira soils to maintain high yields and to maintain or improve tilth.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor

tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is moderately suited to building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

570D2—Nira silty clay loam, 9 to 14 percent slopes, moderately eroded. This is a moderately well drained, strongly sloping soil on plane or convex slopes on uplands. This soil commonly is at the head of waterways and on side slopes between waterways. It is just upslope from a linear area of seepage. The areas generally are long and narrow.

Typically, the surface layer is mixed very dark grayish brown and brown silty clay loam about 8 inches thick. Plowing has mixed some subsoil material into the surface layer. This plow layer directly overlies the subsoil. The subsoil is about 24 inches thick. In the upper part, it is brown silty clay loam; in the next part, it is mottled grayish brown and strong brown silty clay loam; and in the lower part, it is light gray and light olive gray silty clay loam that has many strong brown and yellowish red mottles. The substratum is light gray silty clay loam that has strong brown and yellowish red mottles. It overlies clayey, grayish gumbotil that begins at a depth of 4 to 8 feet. The depth to the clay maximum, to the mottles, and to the underlying material is less than that in the uneroded Nira soils. In small areas on side slopes and nose slopes, this Nira soil is severely eroded.

Included in mapping are small areas of Sharpsburg and Ladoga soils on the steeper slopes and areas of the poorly drained Lamoni soils.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 2 percent organic matter. Organic matter in this soil, mainly in the plow layer, amounts to about 35 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is moderately suited to corn, soybeans, and small grains. It is suited to grasses and legumes for hay or pasture and to trees.

If this soil is used for cultivated crops, erosion can cause further damage. Conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Contour farming and terraces can be used to control erosion. In places, interceptor tile needs to be installed to control seepage. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Nira soils to maintain high yields and to maintain or improve tilth.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is moderately suited to building site development and onsite waste disposal. Seepage and slope are limitations to the use of this soil as sewage lagoons. Permeability is a limitation to use as septic tank filter fields. Slope is a limitation to use as building sites. This soil has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed.

Capability subclass IIIe.

675C—Dickinson-Sharpsburg complex, 5 to 9 percent slopes. This complex consists of moderately well drained to somewhat excessively drained, moderately sloping soils on convex slopes or rolling uplands. These soils commonly are on the eastern or southern side of valleys of the larger streams. Slopes are short. The areas of this complex are irregular in shape. The Dickinson soil commonly is on the more convex slopes; the areas are oval or elongated and are oriented in a northwest-southeast direction. The Sharpsburg soil surrounds the areas of the Dickinson soil. This complex is about 60 percent Dickinson soil and about 40 percent Sharpsburg soil. These soils are so intermingled or the areas of each are so small that it was not practical to separate them in mapping at the scale used.

Typically, the surface layer of the Dickinson soil is very dark grayish brown fine sandy loam about 8 inches thick. The subsoil is about 29 inches thick. It is dark brown and brown fine sandy loam in the upper part, brown and very dark grayish brown fine sandy loam in the middle part, and dark yellowish brown loamy fine sand in the lower part. The substratum is yellowish brown fine sand and extends to a depth of more than 60 inches.

Typically, the surface layer of the Sharpsburg soil is black and very dark grayish brown silty clay loam about 16 inches thick. The subsoil is about 28 inches thick. It is brown silty clay loam in the upper part and mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles. The surface layer of this Sharpsburg soil is more sandy than is typical for the series.

Included in mapping are small areas of severely eroded Dickinson soils or areas where glacial till is exposed. Also included are small areas of Nira and Lamoni soils on the lower part of slopes.

Permeability of the Dickinson soil is moderately rapid to rapid. The available water capacity is low. Runoff is medium. The content of available phosphorus and potassium is very low. The surface layer is neutral, and the subsoil is slightly acid to medium acid.

Permeability of the Sharpsburg soil is moderately slow. The available water capacity is high. Runoff is medium. The content of available phosphorous is low, and that of available potassium is medium. If this soil has not been limed, it generally is slightly acid or medium acid.

The average plow layer in this unit is about 3 percent organic matter. On the average, organic matter in the solum amounts to about 60 tons per acre.

These soils are used mainly for cultivated crops. They are moderately suited to corn, soybeans, and oats. They are well suited to alfalfa and hay and to use as pasture. The hazard of erosion by water and wind is moderate to severe. Contour farming and conservation tillage help to reduce erosion. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce erosion, reduce crusting, and increase water infiltration.

Using these soils as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

These soils are suitable for building site development and onsite waste disposal. Erosion is a moderate hazard, and these soils need to be protected. Reducing the length of time that the soil is left without an adequate vegetative cover and reducing the steepness and length of slopes can help to control erosion. The Sharpsburg soil has low strength; therefore, foundations and footings for buildings constructed on the Sharpsburg soil should be designed to prevent structural damage. If the Sharpsburg soil is used as a site for local roads, a suitable base material is needed. Permeability is a limitation to the use of the Dickinson soil for sewage lagoons.

Capability subclass IIIe.

675D2—Dickinson-Sharpsburg complex, 9 to 14 percent slopes, moderately eroded. This complex consists of moderately well drained to somewhat excessively drained, moderately sloping soils on convex slopes or on rolling uplands. These soils commonly are on the eastern or southern side of valleys of the larger streams. Slopes are short. The areas of this complex are irregular in shape. The Dickinson soil commonly is on the more convex slopes; the areas are oval or elongated in shape and are oriented in a northwest-southeast direction. The Sharpsburg soil surrounds the areas of the Dickinson soil. This complex is about 55 percent Dickinson soil and about 45 percent Sharpsburg soil. These soils are so intermingled or the areas of each are so small that it was not practical to separate them in mapping at the scale used.

Typically, the surface layer of the Dickinson soil is very dark grayish brown fine sandy loam about 8 inches thick. The subsoil is about 29 inches thick. It is dark brown and brown fine sandy loam in the upper part, brown and very dark grayish brown fine sandy loam in the next part, and dark yellowish brown loamy fine sand in the lower part. The substratum is yellowish brown fine sand and extends to a depth of more than 60 inches.

Typically, the surface layer of the Sharpsburg soil is very dark grayish brown silty clay loam 8 inches thick. The subsoil is about 24 inches thick. It is brown heavy silty clay loam in the upper part and mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles. This Sharpsburg soil is more sandy and has a lower content of organic matter than is typical for the series.

Included in mapping are very small areas of severely eroded Dickinson soils or areas where glacial till is exposed. Also included are small areas of Nira and Lamoni soils on the lower part of slopes.

Permeability of the Dickinson soil is moderately rapid to rapid. The available water capacity is low. Runoff is medium. The content of available phosphorus and potassium is very low. The surface layer is neutral.

Permeability of the Sharpsburg soil is moderately slow. The available water capacity is high. Runoff is medium. The content of available phosphorus is low, and that of available potassium is medium. The surface layer is slightly acid to medium acid.

The average plow layer in this unit is about 2 percent organic matter. On the average, organic matter in the solum amounts to about 30 tons per acre.

These soils are poorly suited to corn, soybeans, and oats. They are well suited to alfalfa and hay and to use as pasture.

These soils are susceptible to water and wind erosion. A high level of management is needed to maintain a vegetative cover to protect these soils from water and wind erosion. The Dickinson soil is droughty in periods of low rainfall. Crops are stunted and irregular in size. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. To maintain a high yield and to maintain or improve tilth, these soils generally require more nitrogen than the less eroded Dickinson and Sharpsburg soils.

Using these soils as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

These soils are suitable for building site development and onsite waste disposal. Erosion is a hazard, and

these soils need to be protected. Reducing the length of time that the soil is left without an adequate vegetative cover and reducing the steepness and length of slopes can help to control erosion. The Sharpsburg soil has low strength; therefore, foundations and footings for buildings constructed on the Sharpsburg soil should be designed to prevent structural damage. If the Sharpsburg soil is used as a site for local roads, a suitable base material is needed. Permeability is a limitation to the use of the Dickinson soil for sewage lagoons.

Capability subclass IVe.

792D2—Armstrong loam, 9 to 14 percent slopes, moderately eroded. This is a moderately well drained or somewhat poorly drained, strongly sloping soil on uplands. Slopes are convex. The areas generally are irregularly shaped bands or strips that extend on the contour around hill slopes and nose slopes and into coves at the head of drainageways. They are just downslope from a linear area of seepage. In places, this soil is on the top of extended ridges.

Typically, the surface layer is very dark gray and dark grayish brown loam 8 inches thick. In cultivated areas, plowing has mixed some subsoil material and pebbles with material from the surface and subsurface layers. The subsoil is about 56 inches thick. In the upper part, it is dark yellowish brown and brown clay that has grayish brown and yellowish red mottles; in the next part, it is light brownish gray clay that has strong brown mottles; and in the lower part, it is mottled light gray, dark yellowish brown, and strong brown clay loam. A stone line is near the top of the subsoil. In some small areas, this Armstrong soil has slopes of 5 to 9 percent. In small areas on the steeper slopes, this soil is severely eroded, and the reddish subsoil is exposed.

Included in mapping are small areas of Ladoga soils that have slopes of 5 to 9 percent.

Permeability is slow, and the available water capacity is high. Runoff is medium or rapid. The content of available phosphorus and potassium is very low. If this soil has not been limed, the surface layer is acid. The plow layer is about 2 percent organic matter. Organic matter content in the solum amounts to about 25 tons per acre.

This soil is used mainly for cultivated crops and as pasture. It is poorly suited to corn, soybeans, and oats. It is moderately suited to alfalfa. It is well suited to grass for hay or pasture.

In general, this soil requires a higher level of management than the less eroded Armstrong soil. It is seepy in wet periods. The main hazard is erosion caused by runoff. This soil is lower in fertility than the less eroded Armstrong soil. It commonly is cloddy when tilled, and thus seedbed preparation is more difficult. The surface crusts after a heavy rain, thus hindering seedling emergence. Returning crop residue and adding manure to the soil are necessary to maintain soil tilth and productivity. Contour farming and, in places, interceptor tile and terraces are needed to reduce erosion and runoff. If this soil is used as pasture, preventing overgrazing and deferring grazing when the soil is very wet can reduce surface compaction and runoff.

This soil is poorly suited to building site development because the shrink-swell potential is high. It is poorly suited to onsite waste disposal because of the slow permeability and the slope.

Capability subclass IVe.

822C—Lamoni silty clay loam, 5 to 9 percent slopes. This is a somewhat poorly drained, moderately sloping soil near the upper end of drainageways on uplands. Slopes are convex. The areas generally are long, narrow, and irregular and are just downslope from a linear area of seepage.

Typically, the surface layer is black silty clay loam about 10 inches thick. The firm subsoil is about 60 inches thick. It is mottled gray, grayish brown, and yellowish brown clay in the upper part and mottled grayish brown, yellowish brown, and gray clay loam in the lower part. The substratum is yellowish brown clay loam that has gray mottles and grains of sand and gravel. In cultivated areas, the plow layer is mixed black and very dark grayish brown silty clay loam 8 inches thick.

Included in mapping are small areas of Clarinda and Adair soils near the upper boundary of this unit and small areas of Gara and Shelby soils near the lower boundary.

Permeability is slow to very slow, and the available water capacity is high. Runoff is medium or rapid. The content of available phosphorus is low, and that of available potassium is low to medium. If this soil has not been limed, the surface layer generally is acid. The surface layer is about 3 percent organic matter. Organic matter in the solum amounts to about 60 tons per acre.

This soil is used mainly as pasture and for hay. It also is used for cultivated crops. This soil is moderately suited to corn, soybeans, and small grains. It is well suited to grasses and legumes for hay or pasture. It is poorly suited to trees.

If this soil is used for cultivated crops, erosion is a hazard. This soil is difficult to farm. The main limitation is that this soil is very sticky and seepy in wet periods and is very hard when dry. Contour farming and conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. The use of interceptor tile and terraces is difficult on this soil because of the clayey texture; however, these erosion-control practices are effective in most places. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pas-

ture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is poorly suited to building site development because the seasonal water table and the shrink-swell potential are high. It is poorly suited to onsite waste disposal because the seasonal water table is high and the permeability is slow.

Capability subclass IVw.

822C2—Lamoni silty clay loam, 5 to 9 percent slopes, moderately eroded. This is a somewhat poorly drained, moderately sloping soil on convex side slopes near the upper end of drainageways on uplands. The areas generally are long, narrow, and irregular. They are just downslope from a linear area of seepage.

Typically, the surface layer is 8 inches thick. It is mixed very dark grayish brown and dark grayish brown silty clay loam that has yellowish brown mottles. Plowing has mixed material from the upper part of the subsoil into the surface layer. This plow layer directly overlies the firm subsoil. The subsoil is about 56 inches thick. It is mottled gray, grayish brown, and yellowish brown clay in the upper part and mottled grayish brown, yellowish brown, and gray clay loam in the lower part. The substratum is yellowish brown clay loam that has gray mottles.

Included in mapping are small areas of Clarinda and Clearfield soils near the upper boundary of this unit and small areas of Adair soils near the lower boundary.

Permeability is slow to very slow, and the available water capacity is high. Runoff is medium or rapid. The content of available phosphorus is low, and that of available potassium is low to medium. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 35 tons per acre.

This soil is used mainly as pasture and for hay. It also is used for cultivated crops. This soil is moderately suited to corn, soybeans, and oats. It is well suited to alfalfa and pasture. It is poorly suited to trees.

This soil is difficult to farm. It is susceptible to erosion and commonly is wet in spring. This soil is very sticky and seepy in wet periods and is very hard when dry. In areas where the surface layer is eroded, these limitations are more severe. If this soil is used for cultivated crops, erosion can cause further damage. Contour farming and conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. The use of interceptor tile and terraces is difficult on this soil because of the clayey texture; however, these erosion-control practices are effective in most places. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Lamoni soils to maintain a high yield and to maintain or improve tilth.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production.

This soil is poorly suited to building site development because the seasonal water table and the shrink-swell potential are high. It is poorly suited to onsite waste disposal because the seasonal water table is high and the permeability is slow.

Capability subclass IVw.

822D—Lamoni silty clay loam, 9 to 14 percent slopes. This is a somewhat poorly drained, moderately sloping soil near the upper end of drainageways on uplands. Slopes are convex. The areas generally are long, narrow, and irregular and are just downslope from a linear area of seepage.

Typically, the surface layer is black silty clay loam about 10 inches thick. The firm subsoil is about 46 inches thick. It is mottled gray, grayish brown, and yellowish brown clay in the upper part and mottled grayish brown, yellowish brown, and gray clay loam in the lower part. The substratum is yellowish brown clay loam that has gray mottles and grains of sand and gravel. In cultivated areas, the plow layer is mixed black and very dark grayish brown silty clay loam 8 inches thick.

Included in mapping are small areas of Clarinda and Adair soils near the upper boundary of this unit and small areas of Gara and Shelby soils near the lower boundary.

Permeability is slow to very slow, and the available water capacity is high. Runoff is medium or rapid. The content of available phosphorus is low, and that of available potassium is low to medium. If this soil has not been limed, the surface layer generally is acid. The surface layer is about 3 percent organic matter. Organic matter in the solum amounts to about 55 tons per acre.

This soil is used mainly as pasture and for hay. It also is used for cultivated crops. This soil is moderately suited to corn, soybeans, and oats. It is well suited to alfalfa, grass, and hay and to use as pasture. It is poorly suited to trees.

This soil is susceptible to erosion and commonly is wet in spring. It is difficult to farm because it is sticky when wet and hard when dry. Contour farming and conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. The use of interceptor tile and terraces is difficult on this soil because of the clayey texture; however, these erosion-control practices are effective in most places. Returning crop residue or adding other organic material to the soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Lamoni soils to maintain a high yield and to maintain or improve tilth.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is poorly suited to building site development because the seasonal water table and the shrink-swell potential are high. It is poorly suited to onsite waste disposal because the seasonal water table is high and the permeability is slow.

Capability subclass IVe.

822D2—Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded. This is a somewhat poorly drained, strongly sloping soil on convex side slopes near the upper end of drainageways on uplands. The areas generally are long, narrow, and irregular and extend on the contour along side slopes. This soil is downslope from a linear area of seepage.

Typically, the surface layer is 8 inches thick. It is mixed dark grayish brown and very dark grayish brown silty clay loam that has yellowish brown mottles. Plowing has mixed material from the upper part of the subsoil into the surface layer. This plow layer overlies the firm subsoil. The subsoil is about 44 inches thick. It is mottled gray, grayish brown, and yellowish brown clay in the upper part and mottled grayish brown, yellowish brown, and gray clay loam in the lower part. The substratum is yellowish brown clay loam that has gray mottles and grains of sand and gravel. In small areas where slopes are steepest, this Lamoni soil is severely eroded.

Included in mapping are small areas of Clarinda and Adair soils near the upper boundary of this unit and small areas of Shelby and Gara soils near the lower boundary.

Permeability is slow to very slow, and the available water capacity is high. Runoff is medium or rapid. The content of available phosphorus is low, and that of available potassium is low to medium. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 30 tons per acre.

This soil is used mainly as pasture and for hay. It also is used for cultivated crops. This soil is poorly suited to corn, soybeans, and oats. It is well suited to alfalfa and grass for hay and to use as pasture. It is poorly suited to trees.

This soil is more susceptible to erosion, is more sticky when wet, is harder when dry, and has poorer tilth than the less eroded Lamoni soils. Preparing a good seedbed also is more difficult. This soil is very sticky and seepy in wet periods, and it is very hard when dry. If the surface layer is eroded, these limitations are more severe. The main hazard is erosion. Contour farming and conservation tillage can help to prevent excessive soil loss, and grassed waterways can help to prevent gully erosion. Erosion control practices, including the use of interceptor tile and terraces, are difficult because this Lamoni soil is clayey, but they are effective in most places. Returning crop residue or adding other organic material to this soil helps to improve fertility, reduce soil erosion, reduce crusting, and increase water infiltration. This soil generally requires more nitrogen than the less eroded Lamoni soils to maintain high yields and to maintain or improve tilth.

Using this soil as pastureland or hayland also is effective in controlling erosion. However, overgrazing can cause surface compaction, increase runoff, result in poor tilth, and reduce production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep pasture and soil in good condition.

This soil is poorly suited to building site development because the seasonal water table and the shrink-swell potential are high. It is poorly suited to onsite waste disposal because the seasonal water table is high and the permeability is slow.

Capability subclass IVe.

822D3—Lamoni clay, 9 to 14 percent slopes, severely eroded. This is a somewhat poorly drained, strongly sloping soil on convex side slopes on uplands. The areas are long and narrow.

Typically, the surface layer is 8 inches thick. It is mixed dark grayish brown and grayish brown clay that has yellowish brown mottles. The subsoil is about 40 inches thick. It is mottled gray, grayish brown, and gray clay in the upper part and mottled grayish brown, yellowish brown, and gray clay loam in the lower part. The substratum is yellowish brown clay loam that has gray mottles and grains of sand and gravel.

Included in mapping are moderately eroded Adair soils in the less sloping areas.

Permeability is slow to very slow, and the available water capacity is high. Runoff is rapid. The content of available phosphorus is low, and that of available potassium is low to medium. If this soil has not been limed, the surface layer generally is acid. The plow layer is about 1 percent organic matter. Organic matter in the solum amounts to about 15 tons per acre.

This soil is used mainly as pasture and for hay. It also is used for cultivated crops. This soil is poorly suited to corn, soybeans, and oats. It is moderately suited to alfalfa and poorly suited to trees. It is best suited to grass.

This soil is susceptible to erosion. It is difficult to farm because it is very sticky and seepy in wet periods and is very hard when dry. These limitations are severest where the surface layer is severely eroded. This soil is lower in fertility than the uneroded or moderately eroded Lamoni soils. The surface layer has poor tilth and is cloddy. Preparing a seedbed is very difficult. The main hazard is erosion. Contour farming and conservation tillage can help to prevent excessive soil loss, and grassed water-

ways can help to prevent gully erosion. In places, interceptor tile and terraces are needed to control erosion.

This soil is poorly suited to building site development and onsite waste disposal. Seepage and slope are limitations to the use of this soil for sewage lagoons. Permeability is a limitation to use as septic tank filter fields. The seasonal high water table and the high shrink-swell potential are limitations to use as sites for buildings and local roads.

Capability subclass VIe.

870B—Sharpsburg silty clay loam, benches, 2 to 5 percent slopes. This is a moderately well drained, gently sloping soil. This soil is on loess-covered benches along the edge of valleys of the larger streams. Slopes are smooth and convex.

Typically, the surface layer is 21 inches thick. It is black silty clay loam in the upper part and black and very dark grayish brown silty clay loam in the lower part. The subsoil is about 29 inches thick. It is brown silty clay loam in the upper part and mottled grayish brown, brown, yellowish brown, and dark yellowish brown silty clay loam in the lower part. The substratum is light brownish gray silty clay loam that has strong brown mottles. This soil is similar to the one described as typical of the Sharpsburg series except that it is underlain by sandy alluvium at a depth of 7 to 10 feet. In some areas on the benches along the Nodaway and Middle Rivers, this soil has slopes of 0 to 2 percent.

Included in mapping are small areas of Ladoga soils. These soils have a silt loam surface layer and are steeper than this Sharpsburg soil.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is low, and that of available potassium is medium. If this soil has not been limed, it generally is slightly acid or medium acid. Organic matter in the solum amounts to about 85 tons per acre. The plow layer is about 4 percent organic matter.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, grass and alfalfa hay, and trees and to use as pasture. This soil is not subject to stream overflow, but in some areas it receives runoff from soils upslope. It is susceptible to erosion. Conservation tillage, contour farming, and terraces on long slopes can help to reduce erosion. If this soil is used as pasture, preventing overgrazing and deferring grazing when this soil is very wet can reduce surface compaction and runoff.

This soil is suitable for building site development and onsite waste disposal. It has low strength; therefore, building foundations and footings need to be designed to prevent structural damage. If this soil is used as a site for local roads, a suitable base material is needed. Permeability is a limitation to the use of this soil as septic tank filter fields.

Capability subclass IIe.

876B—Ladoga silt loam, benches, 2 to 5 percent slopes. This is a moderately well drained, gently sloping soil on loess-covered benches on bottom lands in the wider valleys. It is underlain by sandy alluvium at a depth between 7 and 10 feet.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is about 44 inches thick. In the upper part, it is brown silty clay loam that has a few yellowish brown mottles, and in the lower part, it is mottled grayish brown and dark yellowish brown silty clay loam. The substratum is light brownish gray silty clay loam that has yellowish brown mottles. In cultivated areas, the plow layer, which is a mixture of material from the surface and subsurface layers, is very dark grayish brown silt loam.

Included in mapping are small areas of Sharpsburg soils in the less sloping areas. Also included are small areas of gently sloping, bench-phase Clinton soils and a few small areas of sandy Dickinson soils in areas where slopes are more convex.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is medium, and that of available potassium is very low. If this soil has not been limed, the surface layer generally is medium acid. The plow layer is about 3 percent organic matter. Organic matter in the solum amounts to about 50 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, hay, and trees and to use as pasture. This soil is susceptible to erosion. Contour farming and conservation tillage help to reduce erosion. If this soil is used as pasture, preventing overgrazing can reduce runoff and erosion.

This soil is suitable for building site development and onsite waste disposal. Erosion is a slight hazard, and the soil needs to be protected. Reducing the length of time that the soil is left without an adequate vegetative cover and reducing the steepness and length of slopes can help to control erosion. This soil has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a suitable base material is needed.

Capability subclass IIe.

876C—Ladoga silt loam, benches, 5 to 9 percent slopes. This is a moderately well drained, moderately sloping soil. This soil is on convex slopes on benches and on short side slopes of loess-covered benches on bottom lands in the wider valleys. It is underlain by sandy alluvium at a depth between 7 and 10 feet.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 3 inches thick. The subsoil is about 40 inches thick. In the upper part, it is brown silty clay loam that has a few yellowish brown mottles, and in

the lower part it is mottled grayish brown and dark yellowish brown silty clay loam. The substratum is light brownish gray silty clay loam that has yellowish brown mottles. In cultivated areas, the plow layer, which is a mixture of material from the surface and subsurface layers, is dark grayish brown silt loam. In places, this soil is severely eroded, and in some extensive areas, it is moderately eroded.

Included in mapping are small areas of bench-phase Clinton soils in areas where slopes are steep and convex.

Permeability is moderately slow, and the available water capacity is high. Runoff is medium. The content of available phosphorus is medium, and that of available potassium is very low. If this soil has not been limed, the surface layer generally is medium acid. The plow layer is about 3 percent organic matter. Organic matter in the solum amounts to about 45 tons per acre.

This soil is used mainly for cultivated crops. It is well suited to corn, soybeans, oats, hay, and trees and to use as pasture. This soil is susceptible to erosion. Contour farming, conservation tillage, and terraces on long slopes help to reduce erosion. If this soil is used as pasture, preventing overgrazing can reduce runoff.

This soil is suitable for building site development and onsite waste disposal. It has low strength; therefore, foundations and footings for buildings should be designed to prevent structural damage. If this soil is used as a site for local roads, a more suitable base material is needed. Slope is a limitation to sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IIIe.

993D2—Gara-Armstrong loams, 9 to 14 percent slopes, moderately eroded. This map unit consists of moderately well drained to well drained or somewhat poorly drained, strongly sloping soils on hillsides on uplands. Slopes are long and convex. The areas are long, narrow, and irregular and extend horizontally along hillsides. The Gara soil is on the lower part of slopes and makes up about 65 percent of the map unit. The Armstrong soil is on the upper part of slopes and makes up about 25 percent of the unit. These soils are so intermingled or the areas of each are so small that it was not practical to separate them in mapping at the scale used.

Typically, the surface layer of the Gara soil is dark grayish brown and brown loam 8 inches thick. In cultivated areas, plowing has mixed some subsoil material with material from the eroded surface and subsurface layers. Consequently, the plow layer directly overlies the subsoil. The subsoil is about 36 inches thick. In the upper part, it is dark yellowish brown clay loam that has strong brown and yellowish brown mottles, and in the lower part it is mainly mottled strong brown and grayish brown clay loam. The substratum is calcareous, mottled light gray, dark yellowish brown, and brown clay loam.

Typically, the surface layer of the Armstrong soil is very dark gray and dark grayish brown loam about 8 inches thick. The subsoil is about 56 inches thick. In the upper part, it is dark yellowish brown and brown clay that has grayish brown and yellowish red mottles; in the middle part, it is light brownish gray clay that has strong brown mottles; and in the lower part, it is mottled light gray, dark yellowish brown, and strong brown clay loam.

Included in mapping and making up about 10 percent of the unit are small areas of Ladoga, Clarinda, and Lamoni soils along the upper boundary of the unit. Also included on the steeper slopes are small areas of severely eroded soils that have a clay loam surface layer.

Permeability of these soils is moderately slow to slow, and the available water capacity is high. Runoff is medium or rapid. The content of available phosphorus is very low or low, and that of available potassium is very low. If these soils have not been limed, the surface layer generally is acid. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 25 tons per acre.

These soils are used mainly for cultivated crops and hay and as pasture. They are poorly suited to corn, soybeans, and oats. They are well suited to grass and alfalfa for hay or pasture and to trees. Most areas have been cleared, and the soils are used as pasture.

In general, these soils require a higher level of management than the uneroded Gara and Armstrong soils to prevent excessive soil loss. They are lower in fertility than the uneroded soils. They commonly are cloddy when tilled, and thus seedbed preparation is more difficult. Returning crop residue and adding manure to the soil are necessary to improve or maintain soil tilth and productivity. Contour farming, terraces, and interceptor tile help to reduce erosion and runoff.

In managing pastureland, more fertilizer and more intensive erosion control are required for these soils than for the uneroded Gara and Armstrong soils. Preventing overgrazing and deferring grazing when these soils are very wet reduce surface compaction and runoff.

These soils are moderately suited to building site development and onsite waste disposal. Seepage and slope are limitations to the use of these soils as sites for buildings, roads, and sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass IVe.

993E2—Gara-Armstrong loams, 14 to 18 percent slopes, moderately eroded. This map unit consists of moderately well drained to well drained or somewhat poorly drained, moderately steep soils on hillsides on uplands. Slopes are long and convex. The areas are long, narrow, and irregular and extend horizontally along hillsides. The Gara soil is on the lower part of slopes and makes up about 65 percent of the map unit. The Armstrong soil is on the upper part of slopes and makes up about 25 percent of the unit.

Typically, the surface layer of the Gara soil is dark grayish brown and brown loam about 8 inches thick. In cultivated areas, plowing has mixed some subsoil material with material from the eroded surface and subsurface layers. This plow layer directly overlies the clay loam subsoil. The subsoil is about 34 inches thick. In the upper part, it is dark yellowish brown clay loam that has strong brown and yellowish brown mottles, and in the lower part, it is mainly mottled, strong brown and grayish brown clay loam. The substratum is calcareous, mottled light gray, dark yellowish brown, and brown clay loam. A soil that is similar to this Gara soil but is calcareous beginning at a depth of less than 30 inches is included in areas of the Gara soil.

Typically, the surface layer of the Armstrong soil is very dark gray and dark grayish brown loam about 8 inches thick. The subsoil is about 56 inches thick. In the upper part, it is dark yellowish brown and brown clay that has grayish brown and yellowish red mottles; in the middle part, it is light brownish gray clay that has strong brown mottles; and in the lower part, it is mottled light gray, dark yellowish brown, and strong brown clay loam.

Included in mapping and making up about 10 percent of the unit are small areas of Ladoga soils in the less sloping areas, Lamoni soils at the head of drainageways, and Caleb soils on the lower part of slopes.

Permeability of the Gara soil is moderately slow, and that of the Armstrong soil is slow. The available water capacity is high. Runoff is rapid. The content of available phosphorus and potassium is very low. If these soils have not been limed, the surface layer generally is acid. The plow layer is about 2 percent organic matter. Organic matter in the solum amounts to about 20 tons per acre.

These soils are used mainly for hay and as pasture. They are poorly suited to corn, soybeans, and oats. They are suited to alfalfa or grass for hay or pasture. These soils are suited to trees (fig. 17); however, the timber has been cleared in most areas, and these soils are used as pasture. Preventing overgrazing and deferring grazing when these soils are very wet can reduce surface compaction, runoff, and erosion. If these soils are used for

Figure 17.—An area of Gara-Armstrong loams, 14 to 18 percent slopes, moderately eroded, near the Middle River Valley. These soils are suitable for trees.

cultivated crops, the use of terraces, contour farming, and conservation tillage can help to reduce erosion and runoff.

These soils are moderately suited to building site development and onsite waste disposal. Seepage and slope are limitations to the use of these soils as sites for buildings, roads, and sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass VIe.

993F2—Gara-Armstrong loams, 18 to 25 percent slopes, moderately eroded. This complex consists of moderately well drained to well drained or somewhat poorly drained, steep soils on hillsides on uplands. Slopes are long and convex. The areas are long, narrow, and irregular and extend horizontally along hillsides. The Gara soil makes up about 65 percent of the map unit. The Armstrong soil makes up about 25 percent.

Typically, the surface layer of the Gara soil is dark gray loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 2 inches thick. In cultivated areas, the surface layer is brown loam about 8 inches thick. Cultivation has mixed material from the subsoil with material from the eroded surface and subsurface layers. This plow layer directly overlies the subsoil. The subsoil is about 30 inches thick. In the upper part, it is dark yellowish brown clay loam that has strong brown and yellowish brown mottles, and in the lower part it is mainly mottled, strong brown and grayish brown clay loam. The substratum is calcareous, mottled light gray, dark yellowish brown, and brown clay loam. A soil that is similar to this Gara soil but is calcareous beginning at a depth of less than 30 inches is included in areas of the Gara soil.

Typically, the surface layer of the Armstrong soil is very dark gray loam about 5 inches thick. The subsurface layer is dark grayish brown loam about 2 inches thick. The subsoil is about 50 inches thick. In the upper part, it is dark yellowish brown and brown clay that has grayish brown and yellowish red mottles; in the middle part, it is light brownish gray clay that has strong brown mottles; and in the lower part, it is mottled light gray, dark yellowish brown, and strong brown clay loam.

Included in mapping and making up about 10 percent of the unit are Lamoni soils on shoulder slopes and Caleb soils on the lower part of slopes.

Permeability of the Gara soil is moderately slow, and that of the Armstrong soil is slow. The available water capacity is high. Runoff is rapid. The content of available phosphorus is very low or low, and that of available potassium is very low. If these soils have not been limed, the surface layer generally is acid. The plow layer is about 1 percent organic matter. Organic matter in the solum amounts to about 15 tons per acre.

This map unit is not suited to use as cropland. It is well suited to use as pasture, woodland, or wildlife habitat. In most areas these soils are used as pastureland or hayland. Gully erosion is a severe hazard. Good pasture management is required to maintain an adequate vegetative cover to protect these soils against gully erosion caused by runoff. Preventing overgrazing and deferring grazing when these soils are very wet can reduce surface compaction, runoff, and erosion.

These soils are moderately suited to building site development and onsite waste disposal. Seepage and slope are limitations to the use of these soils as sites for buildings, roads, and sewage lagoons. Permeability is a limitation to use as septic tank filter fields.

Capability subclass VIIe.

5030—Pits-Dumps complex. This map unit consists of areas where the soil has been so altered that the profile has been destroyed or is unrecognizable. The soil has been altered by cut and fill operations; it has been compacted by unusually heavy traffic; or gravel or limestone rock fragments have been imbedded in the soil to a depth of several inches.

This map unit is adjacent to quarries, roads, or other areas that generally are not used for agricultural purposes.

Capability subclass VIs.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops, pasture, and woodland; as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities; and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses

can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

About 72 percent of Adair County is used as cropland, and about 10 percent is used as pasture (*8*). Some pastures are partly wooded. The main crops are corn, soybeans, oats, legumes, and legume-grass hay. Minor crops include sudangrass grown for pasture and sorghum grown for silage.

The main pasture grass is bluegrass. In some places, the stand has been altered and plants such as birdsfoot trefoil have been introduced. Grass-legume mixtures such as alfalfa-bromegrass also are in pastureland.

Drainage tile is used to reduce wetness on bottom land soils such as Colo and Zook soils and on upland soils such as Macksburg and Winterset soils. Interceptor tile is used to reduce wetness on upland soils such as Adair, Clarinda, Clearfield, and Lamoni soils.

Grade stabilization structures, farm ponds, and grassed waterways are used to control gully erosion in water courses. In places, levees are used to protect bottom lands from flooding.

The drainage class of a soil generally is indicated by the color and mottling of the subsoil. For example, Winterset soils have a dominantly gray subsoil, which indicates poor drainage; and Clinton soils have a brownish subsoil, which indicates that they are moderately well drained.

Permeability of a soil also affects management and the suitability of a soil for certain crops. Fine-textured, compact soils such as Zook and Clarinda soils generally have slow or very slow permeability and absorb moisture slowly. Water ponds on the surface, or it runs off rapidly, depending on the slope. Runoff causes erosion, and the erosion is more severe if the soil is cultivated. If artificial drainage is needed, the permeability of the soil should be determined before a drainage system is selected.

Soil texture is also considered in determining the kind of drainage system to be used and the choice of crops to be grown. Fine-textured soils such as Clarinda soils do not absorb moisture rapidly and are difficult to work. Coarse soils such as Dickinson soils do not hold much water available to plants. Soils such as Sharpsburg, Judson, and Olmitz soils have very favorable soil texture.

Soil erosion is influencd by the steepness of slopes and by the amount of vegetation on the surface. The rate of runoff and the hazard of erosion increase as the degree of slope increases. Soils that have slopes of more than 2 percent are subject to erosion if cultivated. Erosion is a greater hazard on soils that are not protected by an adequate plant cover. Steep slopes restrict the use of farm machinery. Steep soils generally support thinner stands of row crops than more nearly level soils.

Grassed backslope terraces and gradient terraces are used to control erosion on Ladoga, Sharpsburg, Shelby, and other similar soils that are subject to sheet and gully erosion. A diversion terrace is used on these soils, on the lower part of slopes, to protect bottom land soils from upland runoff and from erosion or sedimentation.

Crops on most of the soils in Adair County respond to fertilizer. The need for fertilizer is determined by the kind of soil, by past and present management practices, and by the needs of the crop to be grown. Unless the soils in the survey area have been limed within the past 5 years, lime generally needs to be added. A few soils, including Zook soils, generally do not require lime. Soil tests can help to determine the amount of lime and the kind and amount of fertilizer to apply.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the soil is not suited to the crop or the crop is not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. The capability class and subclass are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The capability class or subclass is identified in the description of each map unit in the section "Soil maps for detailed planning."

Woodland management and productivity

Table 6 contains information useful to woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates insignificant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the following order: x, w, t, d, c, s, f, and r.

In table 6 the soils are also rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of major soil limitations.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. In Iowa the site index is based on upland oaks at 50 years of age. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 7 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 7, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. If pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil are included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 8 shows, for each kind of soil, the degree and kind of limitations for building site development; table 9, for sanitary facilities; and table 11, for water management. Table 10 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitation that affects shallow excavations, dwellings with and without a basement, small commercial buildings, and local roads and streets are indicated in table 8. A *slight* limitation indicates that soil properties generally are favorable for the specified use and that limitations are minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils that are rated severe, costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or

extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 8 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, and *poor*, which mean about the same as *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard if the seasonal high water table is above the level of the lagoon floor. If the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer

of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 9 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

If it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the site should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction material. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 14 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can restrict plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils or very firm clayey soils; soils that have suitable layers less than 8 inches thick; soils that have large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water-control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of the soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 12 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 8.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but re-

mains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 13, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of habitat are very severe and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, orchardgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of hardwood plants are oak, poplar, cherry, apple, hawthorn, dogwood, hickory, and elderberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capac-

ity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, and cordgrass and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, forbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 14 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 14 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 14 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters ir diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two

classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection. The estimated classification, without group index numbers, is given in table 14. Also in table 14 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and in plasticity index is estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 15 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems. In table 15 it is expressed as inches of water per inch of soil.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation

is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used. Fall tillage on soybean land greatly increases the hazard of soil blowing in winter and spring.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 16 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine

how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*30*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 17, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *Udolls*, the suborder of Mollisols that have a udic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine, montmorillonitic, mesic Typic Argiudolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*28*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Ackmore series

The Ackmore series consists of deep, somewhat poorly drained or poorly drained soils. The Ackmore soils formed in silty alluvium. The native vegetation was grass. These soils are on smooth flood plains. Slopes are 0 to 2 percent. Permeability is moderately slow.

These soils are a taxadjunct to the Ackmore series because they do not have mottles or a chroma of less than 1 if the value is mainly less than 4 within a depth of 20 inches. This difference does not affect their use and behavior.

Ackmore soils are adjacent to Colo, Nodaway, and Zook soils. Ackmore soils are more stratified than Colo and Zook soils. They have a darker surface layer than Nodaway soils. They have a buried soil, which the Colo, Nodaway, and Zook soils do not have.

Typical pedon of Ackmore silty clay loam, 0 to 2 percent slopes, on a creek bottom, 14 feet west and 450 feet north of southeast corner of sec. 2, T. 77 N., R. 30 W.

A1—0 to 10 inches; black (10YR 2/1) light silty clay loam with some thin strata of very dark grayish brown (10YR 3/2); weak fine granular structure; friable; slightly acid; clear smooth boundary.

C1—10 to 25 inches; stratified black (10YR 2/1) light silty clay loam and heavy silt loam with thin strata of grayish brown (10YR 5/2), dark grayish brown (10YR 4/2), and very dark grayish brown (10YR 3/2); moderate thin and medium platy structure parting to weak fine subangular blocky; friable; neutral; abrupt smooth boundary.

Ab—25 to 39 inches; black (N 2/0) light silty clay loam; black (10YR 2/1) on faces of peds; weak medium subangular blocky structure that parts to weak fine granular above a depth of 32 inches, and moderate fine and very fine subangular blocky structure below a depth of 32 inches; friable; neutral; clear smooth boundary.

B1b—39 to 50 inches; black (N 2/0) heavy silty clay loam and light silty clay; strong medium granular and very fine subangular blocky structure; firm; neutral; clear smooth boundary.

B2b—50 to 62 inches; black (N 2/0) heavy silty clay loam; strong fine and very fine subangular blocky structure; firm; neutral; clear smooth boundary.

The depth to the Ab horizon is 24 to 36 inches. The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is light silty clay loam or silt loam. The A horizon is 10 to 20 inches thick and is slightly acid or neutral.

The C1 horizon ranges from very dark gray (10YR 3/1) to black (10YR 2/1) and has thin strata of dark gray (10YR 4/1) to brownish gray (10YR 6/2). It is light silty clay loam or silt loam.

The Ab horizon ranges from light to heavy silty clay loam. It is slightly acid or neutral. The B1b and B2b horizons range from silty clay loam to light silty clay. They are slightly acid or neutral.

Adair series

The Adair series consists of deep, somewhat poorly drained or moderately well drained soils that formed in a thin layer of loess and the underlying glacial till. These soils are on convex side slopes and some ridges on uplands. Slopes range from 5 to 18 percent. Permeability is slow.

These soils are a taxadjunct to the Adair series because they do not have a mollic epipedon. This difference does not alter the use and behavior of these soils.

Adair soils are adjacent to Clarinda, Lamoni, Shelby, and Sharpsburg soils. Adair soils have a redder hue in the subsoil than those soils. They have a thicker A1 horizon than Armstrong soils. They have a higher content of clay in the subsoil than Sharpsburg and Shelby soils.

Typical pedon of Adair clay loam, 9 to 14 percent slopes, moderately eroded, in pasture on an east-facing slope, 400 feet west and 1,120 feet north of southeast corner of sec. 2, T. 77 N., R. 30 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) and brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) rubbed; moderate fine subangular blocky structure; firm; medium acid; clear smooth boundary.

B21t—8 to 15 inches; dark brown (7.5YR 3/2) and brown (7.5YR 4/4) heavy clay loam; few fine distinct reddish brown (5YR 4/4) mottles; moderate fine and very fine subangular blocky structure; moderately thick, nearly continuous clay films on faces of peds; firm; strongly acid; clear smooth boundary.

IIB22t—15 to 20 inches; brown (7.5YR 4/4) light clay; many fine prominent red (2.5YR 4/6) and dark red (2.5YR 3/6) and common fine distinct grayish brown (2.5YR 5/2) mottles; moderate fine subangular blocky structure; very firm; thick nearly continuous clay films; pebble band at a depth of about 16 inches; strongly acid; gradual smooth boundary.

IIB23t—20 to 26 inches; mixed brown (7.5YR 5/4) and strong brown (7.5YR 5/6) light clay; many fine distinct yellowish red (5YR 4/6) mottles in the upper 4 inches; weak medium prismatic structure parting to moderate fine subangular blocky; firm; thick discontinuous clay films; medium acid; clear smooth boundary.

IIB24t—26 to 41 inches; strong brown (7.5YR 5/6) and some brown (7.5YR 5/4) heavy clay loam; few fine prominent grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; firm; thick nearly continuous clay films; many fine black concretions; medium acid; clear smooth boundary.

IIB3t—41 to 60 inches; mottled yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6 and 5/8) heavy clay loam; common fine distinct grayish brown mottles; weak medium prismatic structure; firm; moderately thick discontinuous clay films; few black concretions; medium acid; clear smooth boundary.

IIC—60 to 72 inches; mottled yellowish brown (10YR 5/8), strong brown (7.5YR 5/6 and 5/8), grayish brown (2.5Y 5/2), and light olive gray (5Y 6/2) clay loam; massive; friable; many soft white lime accumulations; neutral.

The solum is 44 to 64 inches thick. The Ap horizon is very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), or brown (10YR 4/3). The A horizon is dominantly clay loam but ranges to loam. It is medium acid or slightly acid.

The IIB horizon is strongly acid to slightly acid. The IIC horizon is medium acid to mildly alkaline.

Arbor series

The Arbor series consists of deep, well drained and moderately well drained soils that formed in loamy local alluvium and in the underlying Kansan till. The native vegetation was grass. These soils are on slightly concave to plane foot slopes on uplands. Slopes are 9 to 14 percent. Permeability is moderately slow.

Arbor soils are adjacent to Olmitz and Shelby soils. They are not so deep to the glacial till as Olmitz soils. They have a thicker A horizon than Shelby soils.

Typical pedon of Arbor loam, 9 to 14 percent slopes, in cropland, on a north-facing, slightly concave slope, 490 feet east and 100 feet south of northwest corner of NW1/4SE1/4NW1/4 sec. 18, T. 76 N., R. 31 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) heavy loam; weak fine and medium granular structure; friable; medium acid; gradual smooth boundary.

A12—6 to 14 inches; very dark brown (10YR 2/2) heavy loam; moderate fine and medium granular structure; friable; medium acid; gradual smooth boundary.

A3—14 to 18 inches; very dark brown (10YR 2/2) heavy loam; weak fine subangular blocky structure; friable; some browner peds from below; medium acid; clear smooth boundary.

B21—18 to 24 inches; brown (10YR 4/3) light clay loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; medium acid; abrupt smooth boundary.

IIB2t—24 to 32 inches; brown (10YR 4/3) light clay loam; moderate fine subangular blocky structure; friable; few thin discontinuous clay films; few stones and pebbles; medium acid; gradual smooth boundary.

IIB3t—32 to 44 inches; brown (10YR 4/3 to 10YR 5/3) light clay loam; few fine faint grayish brown (10YR 5/2) and common distinct strong brown (7.5YR 5/6) mottles; weak medium blocky structure in upper part and weak coarse blocky structure in lower part; friable; very few thin discontinuous clay films; few stones and pebbles; slightly acid; gradual smooth boundary.

IIC—44 to 60 inches; brown (10YR 4/3) and yellowish brown (10YR 5/4) light clay loam; common distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; massive with some vertical cleavage; friable; few stones and pebbles; neutral.

The solum is 38 to 48 inches thick. The A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). The A horizon is dominantly heavy loam but ranges to light clay loam. It is 16 to 24 inches thick and is slightly acid or medium acid.

The B2 horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). There are no pebbles or stones above the IIB2 horizon. The IIB horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6).

Armstrong series

The Armstrong series consists of deep, moderately well drained or somewhat poorly drained soils. These soils formed mainly in glacial till; the upper part of the soil formed later in loess or in loess and pedisediment. The native vegetation was grass and trees. These soils are on convex side slopes and on ridges on uplands. Slopes range from 9 to 25 percent. Permeability is slow.

These soils are a taxadjunct to the Armstrong series because the color value of moist soil is 4 or higher in the surface layer, and this exceeds the defined range for the series. This difference does not alter the use and behavior of these soils.

Armstrong soils are adjacent to Clinton, Gara, and Ladoga soils. Armstrong soils are more clayey and have redder colors in the subsoil than Gara soils. Unlike Adair soils, they have an A2 horizon. They have a thinner A1 horizon than Adair soils.

Typical pedon of uneroded Armstrong loam in an area of Armstrong loam, 9 to 14 percent slopes, moderately eroded, on a ridge in pasture, 350 feet west and 700 feet south of northeast corner of sec. 34, T. 75 N., R. 30 W.

A1—0 to 6 inches; very dark gray (10YR 3/1) loam; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A2—6 to 12 inches; dark grayish brown (10YR 4/2) loam; weak thin platy structure that parts to moderate fine subangular blocky; friable; many gray silt coatings; slightly acid; clear smooth boundary.

B1—12 to 16 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; friable; many gray silt coatings; pebble band at a depth of 16 inches; medium acid; clear smooth boundary.

IIB21t—16 to 23 inches; brown (7.5YR 4/4) clay; common fine faint dark yellowish brown (10YR 4/4) and common fine prominent grayish brown (10YR 5/2) and red (5YR 4/6) mottles; moderate fine subangular blocky structure; firm; moderately thick discontinuous clay films; some coarse sand and gravel; strongly acid; clear smooth boundary.

IIB22t—23 to 30 inches; mottled light brownish gray (10YR 6/2) and strong brown (7.5YR 5/6) light clay; moderate fine and medium subangular blocky structure; firm; thin discontinuous clay films; few medium sand grains; strongly acid; gradual smooth boundary.

IIB23t—30 to 41 inches; light brownish gray (10YR 6/2) light clay; common fine and medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin discontinuous clay films; common medium and coarse sand grains; medium acid; clear smooth boundary.

IIB31t—41 to 55 inches; mottled light gray (10YR 6/1), yellowish brown (10YR 5/4), and dark yellowish brown (10YR 4/4) heavy clay loam; moderate medium subangular blocky structure; firm; thin discontinuous clay films; common coarse sand grains and pebbles; medium acid; clear smooth boundary.

IIB32t—55 to 72 inches; mottled light gray (10YR 6/1), dark yellowish brown (10YR 4/4), and strong brown (7.5YR 5/6) clay loam; moderate medium subangular blocky structure; friable; thin discontinuous clay films; many soft fine lime concretions; neutral.

The solum is 44 to 76 inches thick. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It ranges from loam or silt loam to light clay loam. It is 6 to 10 inches thick and is medium acid or slightly acid. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3). It is 3 to 6 inches thick and is medium acid or slightly acid. In most areas, this soil has been cultivated and is eroded. In these areas, the Ap horizon is very dark grayish brown (10YR 3/2) and brown (10YR 4/3) mixed light clay loam that directly overlies the B horizon.

The IIB2t horizon has gray silt coatings that range from nearly continuous to none in the upper part. The IIB2t horizon ranges from heavy clay loam to clay. It is medium acid or strongly acid.

Caleb series

The Caleb series consists of deep, moderately well drained soils that formed in alluvium that derived from glacial till. The native vegetation was grass and trees. These soils are on low, stepped ridges just upslope from bottom lands. Slopes range from 9 to 14 percent. Permeability is moderately slow in the B2 horizon and is moderate to moderately rapid in the B3 and C horizons.

These soils are a taxadjunct to the Caleb series because the solum is less than 60 inches thick. This difference does not alter the use and behavior of these soils.

Caleb soils are adjacent to Gara, Ladoga, and Shelby soils. Caleb soils are more sandy than those soils. Ladoga soils formed in loess and are much more silty than Caleb soils. Unlike Gara, Ladoga, and Shelby soils, Caleb soils are stratified.

Typical pedon of Caleb loam, 9 to 14 percent slopes, moderately eroded, in grass, on a northeast-facing slope on crest of interfluve, 2,625 feet east and 2,000 feet north of southwest corner of sec. 30, T. 75 N., R. 33 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) heavy loam; very dark gray (10YR 3/1) organic coatings on faces of peds; common small brown (10YR 4/3) particles from the B1 horizon; moderate fine and medium granular and moderate fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

B1—6 to 10 inches; dark yellowish brown (10YR 4/4) light clay loam; brown (10YR 4/3) and a few very dark gray (10YR 3/1) coatings on faces of peds; moderate fine and medium subangular blocky structure; friable; few fine dark concretions; slightly acid; clear smooth boundary.

B21t—10 to 16 inches; dark yellowish brown (10YR 4/4) clay loam; brown (10YR 4/3) coatings on peds; moderate fine and medium subangular blocky structure; friable; thin discontinuous clay films; few fine dark concretions; slightly acid; gradual smooth boundary.

B22t—16 to 22 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; friable; thin discontinuous clay films; few fine

dark and few yellowish brown concretions; slightly acid; gradual smooth boundary.

B23t—22 to 28 inches; dark yellowish brown (10YR 4/4) light clay loam; few fine distinct yellowish red (5YR 4/6) and yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; 1/4-inch thick lens of dark brown (7.5YR 4/4) loamy sand at a depth of 23 inches; thin discontinuous pinkish gray (7.5YR 7/2) silt coatings; few fine dark concretions; slightly acid; clear smooth boundary.

B3—28 to 48 inches; stratified yellowish brown (10YR 5/4 and 5/6) and pale brown (10YR 6/3) light clay loam, sandy clay loam, and fine sandy loam; thin lenses of loamy sand at a depth of 32, 35, 43, and 47 inches; few fine distinct brown (7.5YR 5/4) mottles; weak thin and medium platy structure and weak coarse and medium subangular blocky; friable; few fine dark concretions; medium acid; clear smooth boundary.

C1—48 to 67 inches; stratified yellowish brown (10YR 5/4 and 5/6), brown (10YR 4/3), and light yellowish brown (10YR 6/4) light clay loam, sandy clay loam, and fine sandy loam; thin lenses of loamy sand at a depth of 52, 58, 61, and 66 inches; few fine distinct brown (7.5YR 4/4) mottles; moderate thin and medium platy structure and weak medium subangular blocky; friable; many fine dark concretions; medium acid.

The solum is 44 to 60 inches thick. The Ap horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1) loam or silt loam. In some pedons, the A horizon includes a thin dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), or brown (10YR 4/3 and 5/3) layer below the Ap or A1 horizon. The A horizon is 6 to 10 inches thick. It is medium acid to slightly acid, unless the soil has been limed.

The upper part of the B horizon ranges from brown (10YR 4/3 or 5/3) to dark yellowish brown (10YR 4/4). It ranges from clay loam to sandy clay loam and loam.

Clarinda series

The Clarinda series consists of deep, poorly drained soils that formed mainly in grayish-colored, clayey glacial till of Kansan age. The surface layer formed in loess. The native vegetation was grass. These soils are on convex side slopes and in coves at the head of drainageways on uplands. Slopes range from 5 to 14 percent. Permeability is very slow. These soils are commonly called gumbotil.

These soils are a taxadjunct to the Clarinda series because the pH in the subsoil is higher than defined in the range for the series. Also, the Clarinda soil in map units 222C2 and 222D2 does not have a mollic epipedon. These differences do not affect the use and behavior characteristics of these soils.

Clarinda soils are adjacent to Adair, Clearfield, Lamoni, and Nira soils. Clarinda soils are more clayey than Clearfield and Nira soils. They are grayer and they have less sand and gravel in the B horizon than Adair and Lamoni soils.

Typical pedon of Clarinda silty clay loam, 5 to 9 percent slopes, in pasture, near the upper end of a drainageway, 800 feet east and 1,400 feet north of the southwest corner of sec. 15, T. 77 N., R. 30 W.

A1—0 to 8 inches; black (10YR 2/1) silty clay loam; moderate fine granular structure; friable; slightly acid; clear irregular boundary.

A3—8 to 13 inches; very dark gray (10YR 3/1) heavy silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; some black (10YR 2/1) tongues in upper part of horizon; some dark gray (10YR 4/1) tongues in lower part of horizon; moderate fine subangular blocky structure; friable; slightly acid; clear wavy boundary.

IIB1t—13 to 21 inches; gray (10YR 5/1) and some dark gray (10YR 4/1) silty clay; few medium distinct dark yellowish brown (10YR 4/4) mottles; some black (10YR 2/1) material from the surface layer in cracks caused by shrinking; moderate fine subangular blocky structure; firm; discontinuous moderately thick gray clay films; few fine sand grains; neutral; clear smooth boundary.

IIB21tg—21 to 40 inches; gray (10YR 5/1 and 5Y 5/1) clay; common fine distinct light olive brown (2.5Y 5/4) and few yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; nearly continuous thick gray clay films; few fine sand grains; neutral; gradual smooth boundary.

IIB22tg—40 to 57 inches; gray (5Y 5/1) clay; common fine prominent yellowish brown (10YR 5/4 and 5/6) mottles; moderate medium subangular blocky structure; firm; discontinuous thick gray clay films; few fine sand grains; neutral; clear smooth boundary.

IIB3g—57 to 73 inches; mottled gray (5Y 5/1), brown (7.5YR 4/4), and yellowish brown (10YR 5/6) clay; weak medium subangular blocky structure; firm; few fine sand grains; neutral.

The solum is 60 to 80 inches thick. The A horizon ranges from black (10YR 2/1) to dark gray (10YR 3/1). It ranges from silty clay loam to heavy silty clay loam. The A horizon is 10 to 15 inches thick and is medium acid or slightly acid.

The color range of the IIB horizon is mainly determined by the amount and distinctness of mottles. The IIB horizon is about 50 to 60 percent clay. It has none to common fine sand grains. The IIB horizon is 40 to 70 inches thick and is variable in reaction.

Clearfield series

The Clearfield series consists of deep, poorly drained or somewhat poorly drained soils that formed in loess 3 to 5 feet thick and the underlying clayey glacial till. The native vegetation was grass. These sloping soils are in seepy areas in coves around the head of drainageways on uplands. Slopes are 5 to 9 percent. Permeability is moderately slow in the upper part and very slow in the lower part.

Clearfield soils are adjacent to Adair, Clarinda, Lamoni, and Nira soils. Clearfield soils are less clayey in the B horizon than Clarinda, Lamoni, and Adair soils. They have grayer colors in the upper part of the B horizon than Nira soils.

Typical pedon of Clearfield silty clay loam, 5 to 9 percent slopes, in pasture, near the upper end of a drainageway, 800 feet west and 625 feet north of southeast corner of sec. 22, T. 77 N., R. 30 W.

A1—0 to 7 inches; black (N 2/0) light silty clay loam; few fine distinct dark brown (7.5YR 3/2) and olive (5Y 4/4) accumulations of organic matter in lower part of horizon; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

A3—7 to 14 inches; black (10YR 2/1) light silty clay loam; common fine distinct yellowish brown mottles; common fine distinct dark brown (7.5YR 3/2) and olive (5Y 4/4) accumulations of organic matter in upper part of horizon; few grayish brown (10YR 5/2) accumulations of organic matter in lower part; weak fine granular structure; friable; slightly acid; clear smooth boundary.

B21t—14 to 21 inches; dark gray (10YR 4/1) silty clay loam, dark grayish brown (10YR 4/2 to 2.5Y 4/2) crushed; common fine distinct grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) mottles; few fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure parting to weak very fine subangular blocky; friable; thin discontinuous clay films; common very dark gray (10YR 3/1) and black (10YR 2/1) coatings on faces of peds; slightly acid; clear smooth boundary.

B22tg—21 to 29 inches; mixed grayish brown (2.5Y 5/2 and 10YR 5/2) and gray (10YR 5/1) silty clay loam; common fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak fine subangular blocky structure; friable; thin discontinuous clay films; few soft dark-colored concretions; slightly acid; clear smooth boundary.

B23tg—29 to 40 inches; gray (10YR 5/1) heavy silty clay loam; few fine distinct strong brown (7.5YR 5/6) and dark red (2.5YR 3/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; discontinuous thin black and dark gray organic-clay flows on vertical cleavage; slightly acid; clear smooth boundary.

IIB24tb—40 to 60 inches; dark gray (10YR 4/1) clay; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate fine subangular blocky structure; firm; thin continuous gray clay films; slightly acid; gradual smooth boundary.

IIB25tb—60 to 76 inches; gray (10YR 5/1) clay; weak medium subangular blocky structure; firm; thin continuous gray clay films; slightly acid.

The depth to the clay paleosol is 36 to 60 inches. The A horizon ranges from black (N 2/0 or 10YR 2/1) in the upper part to black (10YR 2/1) or dark gray (10YR 3/1) in the lower part. It is 10 to 17 inches thick and is medium acid to neutral.

The B2 horizon ranges from light silty clay loam to silty clay loam. The IIB horizon is 40 to 50 percent clay.

The Clearfield soil in map unit 69C2 is a taxadjunct to the series; it does not have a mollic epipedon of sufficient thickness. This difference does not affect the use and behavior characteristics of this soil.

Clinton series

The Clinton series consists of deep, moderately well drained soils that formed in loess. The native vegetation was trees. These soils are on ridgetops and convex side slopes on uplands. Slopes range from 5 to 18 percent. Permeability is moderately slow.

Clinton soils are adjacent to Armstrong, Gara, and Ladoga soils. Clinton soils are more silty and less sandy than Armstrong and Gara soils. They have a thinner A1 horizon and are more acid than Ladoga soils.

Typical pedon of Clinton silt loam, 5 to 9 percent slopes, on a ridgetop in timbered pasture, 2,000 feet west and 2,200 feet north of southeast corner of sec. 35, T. 76 N., R. 30 W.

A1—0 to 4 inches; very dark gray (10YR 3/1) silt loam; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

A21—4 to 8 inches; dark grayish brown (10YR 4/2) silt loam; some very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate thin platy structure parting to weak fine subangular blocky; friable; slightly acid; clear smooth boundary.

A22—8 to 12 inches; dark grayish brown (10YR 4/2) heavy silt loam, brown (10YR 4/3) crushed; some very dark grayish brown (10YR 3/2) coatings on faces of peds; weak thin platy structure parting to moderate fine subangular blocky; friable; nearly continuous gray silt coatings; slightly acid; clear smooth boundary.

B21t—12 to 21 inches; dark yellowish brown (10YR 4/4) silty clay loam; strong fine subangular blocky structure; firm; thin continuous brown (10YR 4/3) clay

films; nearly continuous gray silt coatings; medium acid; clear smooth boundary.

B22t—21 to 33 inches; dark yellowish brown (10YR 4/4) heavy silty clay loam; strong fine subangular blocky structure; firm; thin continuous brown (7.5YR 4/3) clay films; discontinuous light gray (10YR 7/2) silt coatings; strongly acid; gradual smooth boundary.

B23t—33 to 44 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) heavy silty clay loam; brown (7.5YR 4/3) coatings on faces of peds; weak medium prismatic structure parting to moderate fine and medium blocky; friable; thin discontinuous clay films; nearly continuous light gray (10YR 7/2) silt coatings; few fine black oxides; medium acid; gradual smooth boundary.

B3t—44 to 64 inches; yellowish brown (10YR 5/4) light silty clay loam; many fine and medium distinct brown (7.5YR 4/4) and light gray (10YR 6/1) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; friable; thin discontinuous clay films; nearly continuous gray silt coatings; few fine black oxides; medium acid; gradual smooth boundary.

C—64 to 96 inches; yellowish brown (10YR 5/4) light silty clay loam; many fine distinct light gray (10YR 6/1) mottles; massive; friable; few medium black oxides; medium acid.

The solum is 48 to 72 inches thick. The A1 horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1). If the A1 horizon is uneroded, it is 2 to 5 inches thick and is medium acid or slightly acid. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3). It is 4 to 10 inches thick and is medium acid or slightly acid. If this soil has been cultivated, the Ap horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 4/3).

The B2t horizon is silty clay loam or heavy silty clay loam. It is medium acid to strongly acid.

Colo series

The Colo series consists of deep, poorly drained soils that formed in silty alluvium. The native vegetation was grass. These soils are on bottom lands. Slopes are 0 to 5 percent. Permeability is moderately slow.

Colo soils are adjacent to Ackmore, Ely, Nodaway, and Zook soils. Unlike Ackmore and Nodaway soils, Colo soils are not stratified. They are more poorly drained than Ely and Nodaway soils. They are less clayey than Zook soils.

Typical pedon of Colo silty clay loam, 0 to 2 percent slopes, in cropland, 54 feet west and 1/4 mile south of northeast corner of sec. 33, T. 75 N., R. 33 W.

Ap—0 to 9 inches; black (10YR 2/1) light silty clay loam; weak fine and medium granular structure; friable; slightly acid; diffuse smooth boundary.

A12—9 to 17 inches; black (10YR 2/1) light silty clay loam; moderate fine and medium granular structure; friable; slightly acid; diffuse smooth boundary.

A13—17 to 27 inches; black (10YR 2/1) light silty clay loam; weak medium prismatic structure parting to moderate fine and medium granular; friable; slightly acid; diffuse smooth boundary.

A14—27 to 36 inches; black (10YR 2/1) silty clay loam; moderate fine and medium subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

B1—36 to 45 inches; black (10YR 2/1) silty clay loam; weak fine prismatic structure that parts to medium subangular and weak angular blocky; firm; few very fine soft brown (7.5YR 4/3) iron oxides; slightly acid; diffuse smooth boundary.

B2—45 to 54 inches; black (10YR 2/1) silty clay loam; moderate medium prismatic structure; firm; few very fine soft brown (7.5YR 4/3) iron oxides; slightly acid; diffuse smooth boundary.

C1g—54 to 62 inches; very dark gray (10YR 3/1) silty clay loam; weak fine and medium prismatic structure; firm; common fine soft brown (7.5YR 4/3) iron oxides; slightly acid; diffuse smooth boundary.

C2g—62 to 71 inches; dark gray (10YR 4/1) and very dark gray (10YR 3/1) silty clay loam; about 10 percent fine sand; weak medium prismatic structure; friable; common fine soft brown (7.5YR 4/4) and black (10YR 2/1) iron oxides; neutral; diffuse smooth boundary.

C3g—71 to 78 inches; grayish brown (2.5Y 5/2) light clay loam; weak medium prismatic structure; friable; many fine soft brown (7.5YR 4/4) iron oxides; common black organic films on faces of root channels; neutral.

The solum is 36 to 54 inches thick. The A horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). It is silt loam to silty clay loam. It is 30 to 50 inches thick and ranges from slightly acid to medium acid.

The B horizon is black (10YR 2/1) or very dark gray (10YR 3/1) and ranges from slightly acid to medium acid. In some pedons it is dark gray (10YR 4/1). In some pedons there is no B horizon.

The C horizon commonly is very dark gray (10YR 3/1) or dark gray (10YR 4/1) but ranges from grayish brown (2.5Y 5/2) to black (10YR 2/1). The C horizon ranges from heavy silty clay loam to loam.

Dickinson series

The Dickinson series consists of deep, well drained or somewhat excessively drained soils that formed in sandy alluvial sediment redeposited by wind. The native vegetation was grass. These soils are on convex ridges and

side slopes on uplands. Slopes range from 5 to 14 percent. Permeability is moderately rapid in the upper part and rapid in the lower part.

These soils are a taxadjunct to the Dickinson series because they do not have a mollic epipedon. This difference does not affect the use and behavior characteristics of these soils.

Dickinson soils are adjacent to Sharpsburg soils. They have coarser particles than Sharpsburg soils.

Typical pedon of Dickinson fine sandy loam, 9 to 14 percent slopes, moderately eroded, in grass, on a slightly convex, east-facing upland slope, 57 feet north and 1,000 feet west of southeast corner of sec. 28, T. 75 N., R. 32 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak fine granular structure; very friable; neutral; clear smooth boundary.

B1—8 to 12 inches; mixed dark brown (10YR 3/3) and brown (10YR 4/3) fine sandy loam; moderate fine subangular blocky structure; very friable; neutral; clear smooth boundary.

B21—12 to 18 inches; brown (10YR 4/3) fine sandy loam; weak medium and fine subangular blocky structure; very friable; very dark grayish brown coatings in root channels; slightly acid; gradual smooth boundary.

B22—18 to 26 inches; brown (10YR 4/3) fine sandy loam and few very dark grayish brown (10YR 3/2) spots; weak medium subangular blocky structure; very friable; medium acid; gradual smooth boundary.

B3—26 to 37 inches; dark yellowish brown (10YR 4/4) loamy fine sand; weak medium subangular blocky structure; loose; medium acid; clear smooth boundary.

C1—37 to 41 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; slightly acid; clear smooth boundary.

C2—41 to 60 inches; dark yellowish brown (10YR 4/4) loamy fine sand; weak medium subangular blocky structure; loose; some indistinct iron bands at a depth of 54 and 57 inches; medium acid; clear smooth boundary.

C3—60 to 67 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; slightly acid; clear smooth boundary.

The solum is 24 to 44 inches thick. The Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A12 horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). If the A horizon is not eroded, it is 10 to 20 inches thick and is neutral or slightly acid.

The B2 horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4). It is slightly acid to strongly acid.

The C horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). It is dominantly loamy sand or sand; however, in some pedons, thin layers of sandy loam are included in the iron bands.

Ely series

The Ely series consists of deep, somewhat poorly drained soils that formed in silty alluvium. The native vegetation was grass. These soils are on foot slopes and fans on bottom lands. Slopes are 2 to 5 percent. Permeability is moderate.

Ely soils are adjacent to Colo, Judson, and Zook soils. Ely soils have higher chroma in the upper part of the B horizon and are better drained than Colo and Zook soils. They have lower chroma in the B horizon and are more poorly drained than Judson soils.

Typical pedon of Ely silty clay loam, 2 to 5 percent slopes, in cropland on a south-facing slope, 1,800 feet south and 45 feet east of northwest corner of sec. 10, T. 75 N., R. 33 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) light silty clay loam; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

A12—8 to 15 inches; black (10YR 2/1) light silty clay loam; moderate fine subangular blocky structure parting to weak fine granular; friable; medium acid; clear smooth boundary.

A3—15 to 22 inches; very dark gray (10YR 3/1) light silty clay loam; few fine faint brown (10YR 4/3) mottles; moderate fine and very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B1—22 to 31 inches; very dark grayish brown (10YR 3/2) light silty clay loam; few medium faint dark yellowish brown (10YR 4/4) mottles; very dark gray (10YR 3/1) coatings on faces of peds; moderate fine and medium subangular blocky structure; friable; nearly continuous gray silt coatings; medium acid; gradual smooth boundary.

B21—31 to 43 inches; dark grayish brown (10YR 4/2) light silty clay loam; common medium faint dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; dark gray (10YR 4/1) and very dark gray (10YR 3/1) coatings on faces of peds; moderate fine and medium subangular blocky structure; friable; nearly continuous light gray silt coatings; few fine soft black oxides; medium acid; gradual smooth boundary.

B22—43 to 57 inches; dark grayish brown (10YR 4/2) light silty clay loam; common medium faint dark gray (10YR 4/1) and distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium subangular blocky structure; friable; few fine black oxides; slightly acid; gradual smooth boundary.

B3—57 to 66 inches; dark grayish brown (10YR 4/2) light silty clay loam; common medium faint dark gray (10YR 4/1) and distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium subangular blocky structure; friable; common fine black oxides; slightly acid.

The solum is 48 to 66 inches thick. The Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It ranges from light silty clay loam to silt loam. The lower part of the A horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark brown (10YR 2/2). The A horizon is 20 to 30 inches thick and is slightly acid to medium acid. The B horizon is light silty clay loam or silty clay loam.

Gara series

The Gara series consists of deep, moderately well drained to well drained soils that formed in glacial till. The native vegetation was grass and trees. These soils are on convex side slopes on uplands. Slopes range from 9 to 25 percent. Permeability is moderately slow.

These soils are a taxadjunct to the Gara series because they have mottles throughout most of the B2 horizon and have gray colors in the B3 horizon. The Gara soils in map units 179D2, 179E2, 179F2, 993D2, 993E2, and 993F2 have color value for moist soil of 4 or higher in the surface layer. These features are not within the defined range for the Gara series; however, they do not affect the use or behavior characteristics of these soils.

Gara soils are adjacent to Armstrong and Ladoga soils. Gara soils are less clayey in the B horizon than Armstrong soils. They are more sandy throughout than Ladoga soils. They have a thinner A1 horizon and are more acid than Shelby soils.

Typical pedon of Gara loam, 14 to 18 percent slopes, moderately eroded, in pasture on a convex slope, 600 feet north and 1,200 feet west of southeast corner of NE1/4 sec. 12, T. 74 N., R. 30 W.

A1—0 to 7 inches; very dark gray (10YR 3/1) loam; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A2—7 to 10 inches; mixed dark grayish brown (10YR 4/2) and brown (10YR 4/3) loam; few very dark gray coatings on faces of peds; weak thin platy structure parting to weak fine and medium granular; friable; medium acid; clear smooth boundary.

B21t—10 to 19 inches; dark yellowish brown (10YR 4/4) clay loam; few fine distinct strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B22t—19 to 26 inches; dark yellowish brown (10YR 4/4) clay loam; many fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; friable; moderately thick nearly continuous clay films on vertical faces; strongly acid; gradual smooth boundary.

B23t—26 to 36 inches; mottled grayish brown (2.5Y 5/2), gray (10YR 5/1), and strong brown (7.5YR 5/6 and 5/8) clay loam; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; thin discontinuous clay films; medium acid; clear smooth boundary.

B31—36 to 43 inches; strong brown (7.5YR 5/8) clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; medium acid; clear wavy boundary.

B32—43 to 48 inches; grayish brown (2.5Y 5/2) clay loam; strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; friable; medium acid; clear wavy boundary.

C1—48 to 65 inches; mottled light gray (10YR 6/1), brown (10YR 5/3), and dark yellowish brown (10YR 4/4) heavy clay loam; massive; friable; common white calcium carbonate concretions; neutral; clear wavy boundary.

C2—65 to 74 inches; light gray (10YR 6/1) clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; massive; friable; common dark yellowish brown concretions; common white calcium carbonate concretions; neutral.

The solum is 36 to 60 inches thick. If the A1 horizon is not eroded, it is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is loam or silt loam. The uneroded A1 horizon is 6 to 9 inches thick and is medium acid or slightly acid. If the Ap horizon is eroded, the color ranges to dark brown (10YR 4/3). The A2 horizon is loam or silt loam. It is 2 to 5 inches thick and is medium acid or strongly acid. The B2t horizon is clay loam that is 33 to 35 percent clay. The C horizon ranges from light clay loam to heavy clay loam.

Humeston series

The Humeston series consists of deep, poorly drained or very poorly drained soils that formed in silty alluvium. The native vegetation was grass. These soils are in slack-water areas on bottom lands. Slopes are 0 to 2 percent. Permeability is moderate or moderately slow in the surface and subsurface layers and very slow in the subsoil.

Humeston soils are adjacent to Colo, Vesser, and Zook soils. Humeston soils have a darker colored and more clayey B horizon than Vesser soils. Unlike Colo and Zook soils, they have a silty A2 horizon.

Typical pedon of Humeston silt loam, 0 to 2 percent slopes, in pasture on bottom lands, 2,200 feet east and 1,400 feet north of southwest corner of sec. 33, T. 75 N., R. 30 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam; very weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

A12—10 to 16 inches; very dark gray (10YR 3/1) silt loam; weak and moderate thin platy structure parting to weak very fine subangular blocky; friable; medium acid; clear smooth boundary.

A13—16 to 24 inches; very dark gray (10YR 3/1) silt loam; weak thin platy structure parting to weak very fine subangular blocky; very friable; medium acid; clear smooth boundary.

A21—24 to 29 inches; dark gray (10YR 4/1) silt loam; few fine faint dark brown (7.5YR 3/2) mottles; moderate thin and very thin platy structure; very friable; medium acid; clear smooth boundary.

A22—29 to 32 inches; very dark gray (10YR 3/1) light silty clay loam; weak thin platy and moderate fine subangular blocky structure; firm; medium acid; clear smooth boundary.

B21t—32 to 41 inches; black (N 2/0) heavy silty clay loam; moderate fine prismatic structure parting to moderate fine subangular blocky; firm; thin discontinuous clay films and organic films; common fine dark concretions; medium acid; gradual smooth boundary.

B22—41 to 53 inches; black (10YR 2/1) heavy silty clay loam; moderate medium prismatic structure parting to moderate medium and fine subangular blocky; firm; thin discontinuous clay films and organic films; common fine hard dark concretions; medium acid; gradual smooth boundary.

B3tg—53 to 67 inches; very dark gray (10YR 3/1) and dark gray (10YR 4/1) heavy silty clay loam; few fine distinct brown (7.5YR 4/4) mottles; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; friable; thin discontinuous clay films; common fine hard dark concretions; slightly acid.

The solum is 60 to 76 inches thick. The A1 horizon is very dark gray (10YR 3/1) or black (10YR 2/1). It is light silty clay loam or silt loam and is 12 to 24 inches thick. The A2 horizon is dominantly dark gray (10YR 4/1) or gray (10YR 5/1). In places it is very dark gray (10YR 3/1) in part of the matrix and has dark brown (7.5YR 3/2) mottles.

The B2t horizon ranges from black (N 2/0) to very dark gray (10YR 3/1) and, in places, has gray mottles. It ranges from heavy silty clay loam to light silty clay. The B horizon of the Humeston soils in Adair County is not so clayey as is typical for the Humeston series; however, it does have at least the minimum clay content described as within the range for the series.

Judson series

The Judson series consists of deep, moderately well drained and well drained soils that formed in local alluvium. The native vegetation was grass. These soils are on alluvial fans and foot slopes. Slopes range from 2 to 9 percent. Permeability is moderate.

Judson soils are adjacent to Ladoga and Sharpsburg soils, upslope, and Colo, Ely, and Kennebec soils, downslope. Judson soils are not so poorly drained as Ely, Colo, and Kennebec soils. They have a thicker A horizon and are less clayey throughout the B horizon than Ladoga and Sharpsburg soils.

Typical pedon of Judson silty clay loam, 5 to 9 percent slopes, in cropland on a south-facing foot slope, 90 feet west and 1,050 feet south of northeast corner of sec. 17, T. 75 N., R. 30 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) light silty clay loam, very dark grayish brown (10YR 3/2) crushed; weak medium granular structure; friable; few clear fine sand grains; slightly acid; clear smooth boundary.

A12—7 to 16 inches; very dark brown (10YR 2/2) light silty clay loam, very dark grayish brown (10YR 3/2) crushed; moderate fine and medium granular structure; friable; few clear fine sand grains; slightly acid; gradual smooth boundary.

A13—16 to 21 inches; very dark brown (10YR 2/2) light silty clay loam, very dark grayish brown (10YR 3/2) crushed; weak very fine subangular blocky structure; friable; few clear fine sand grains; slightly acid; clear smooth boundary.

A3—21 to 29 inches; very dark grayish brown (10YR 3/2) light silty clay loam; moderate fine subangular blocky structure; friable; few clear fine sand grains; slightly acid; gradual smooth boundary.

B2—29 to 35 inches; brown (10YR 4/3) silty clay loam; dark brown (10YR 3/3) coatings on faces of peds; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; few clear fine sand grains; slightly acid; gradual smooth boundary.

B3—35 to 47 inches; mottled yellowish brown (10YR 5/6), dark yellowish brown (10YR 4/4), and grayish brown (10YR 5/2) silty clay loam; dark brown (10YR 3/3) coatings on faces of peds; weak medium prismatic structure parting to weak medium and moderate fine subangular blocky; friable; slightly acid; gradual smooth boundary.

C—47 to 72 inches; mottled light gray (10YR 6/1), brown (10YR 4/3), and dark yellowish brown (10YR 4/4) silty clay loam; massive with vertical cleavage; friable; few fine soft black oxides; slightly acid.

The solum is 40 to 54 inches thick. The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is silt loam to light silty clay loam and is 20 to 30 inches thick. The B2 horizon has a clay maximum of 32 to 35 percent. The B horizon is medium acid to slightly acid.

Kennebec series

The Kennebec series consists of deep, moderately well drained soils that formed in silty alluvium. The native vegetation was grass. These soils are on bottom lands. Slopes are 0 to 2 percent. Permeability is moderate.

These soils are a taxadjunct to the Kennebec series because they have color of 10YR 3/2 in the A1 horizon at a depth that is less than that described in the defined range for the series, and the C horizon is more acid. These differences do not alter the use or behavior of these soils.

Kennebec soils are adjacent to Colo, Nodaway, and Vesser soils. Kennebec soils are darker and are less stratified than Nodaway soils. They are not so clayey as and have better internal drainage than Colo and Vesser soils.

Typical pedon of Kennebec silt loam, 0 to 2 percent slopes, in pasture on bottom land, 130 feet south and 93 feet east of west quarter corner of sec. 36, T. 76 N., R. 30 W.

A11—0 to 8 inches; very dark brown (10YR 2/2) silt loam; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

A12—8 to 16 inches; black (10YR 2/1) silt loam; moderate fine granular structure; slightly acid; clear smooth boundary.

A13—16 to 23 inches; black (10YR 2/1) silt loam; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A14—23 to 37 inches; very dark grayish brown (10YR 3/2) silt loam; very dark gray (10YR 3/1) on faces of peds; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

AC—37 to 48 inches; very dark grayish brown (10YR 3/2) silt loam; very dark gray (10YR 3/1) on faces of peds; weak medium subangular blocky structure; friable; few fine soft dark brown oxides; slightly acid; gradual smooth boundary.

C1—48 to 60 inches; dark grayish brown (10YR 4/2) silt loam; weak fine subangular blocky structure; friable; few fine soft dark brown oxides; medium acid; gradual smooth boundary.

The solum is 36 to 50 inches thick. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is silt loam to light silty clay loam. The C horizon ranges from very dark grayish brown (10YR 3/2) to brown (10YR 5/3).

Ladoga series

The Ladoga series consists of deep, moderately well drained soils that formed in loess. The native vegetation was grass and trees. These soils are on ridgetops and convex side slopes on uplands and on high stream benches along the major rivers. Slopes range from 2 to 18 percent. Permeability is moderately slow.

These soils are a taxadjunct to the Ladoga series because they have grayish brown mottles at a depth of less than that defined in the range for the series. Also, the Ladoga soil in map units 76C2 and 76D2 has color value for moist soil of 4 or higher in the surface layer, and this is more than that in the defined range for the series. These differences do not affect the use or behavior characteristics of these soils.

Ladoga soils are adjacent to Armstrong, Gara, Nira, and Sharpsburg soils. Ladoga soils are more silty in the B horizon than Armstrong and Gara soils. They have a thinner A1 horizon than Nira and Sharpsburg soils.

Typical pedon of Ladoga silt loam, 5 to 9 percent slopes, in pasture, on a ridgetop 200 feet north and 600 feet west of southeast corner of NE1/4 sec. 12, T. 74 N., R. 30 W.

A1—0 to 7 inches; very dark gray (10YR 3/1) heavy silt loam, very dark grayish brown (10YR 3/2) crushed; weak fine granular structure; slightly acid; clear smooth boundary.

A2—7 to 10 inches; dark grayish brown (10YR 4/2) silt loam, brown (10YR 4/3) crushed; weak very thin platy structure parting to weak fine granular and weak very fine subangular blocky; friable; nearly continuous gray silt coatings when dry; medium acid; clear smooth boundary.

B1—10 to 13 inches; brown (10YR 4/3) silty clay loam; moderate very fine subangular blocky structure; firm; nearly continuous gray silt coatings when dry; medium acid; clear smooth boundary.

B21t—13 to 19 inches; brown (10YR 4/3) heavy silty clay loam, yellowish brown (10YR 5/4) crushed; few fine faint yellowish brown (10YR 5/8) mottles; strong fine subangular blocky structure; firm; thin discontinuous clay films; nearly continuous gray silt coatings; strongly acid; clear smooth boundary.

B22t—19 to 26 inches; brown (10YR 4/3) silty clay loam; moderate medium prismatic structure parting to strong fine subangular blocky; friable; thick nearly continuous dark brown clay films; many gray silt coatings; few fine dark oxides; strongly acid; gradual smooth boundary.

B23t—26 to 38 inches; brown (10YR 4/3) silty clay loam; common fine distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6 and 5/8) mottles; moderate medium subangular blocky structure; friable; thin discontinuous clay films on vertical faces of peds; few fine black oxides; medium acid; gradual smooth boundary.

B3t—38 to 50 inches; mottled grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) silty clay loam; weak coarse subangular blocky structure; friable; thin discontinuous clay films on vertical faces of

peds; few fine black oxides; medium acid; gradual smooth boundary.

C1—50 to 63 inches; mottled light brownish gray (10YR 6/2) and yellowish brown (10YR 5/4) light silty clay loam; massive; friable; few thin discontinuous brown stains on vertical faces of peds; medium acid; gradual smooth boundary.

The solum is 40 to 60 inches thick. If the A1 horizon is not eroded, it is very dark gray (10YR 3/1) and very dark brown (10YR 2/2). The A1 horizon is 6 to 10 inches thick and is medium acid or slightly acid. In cultivated areas, the Ap horizon ranges from very dark grayish brown (10YR 3/2) to dark brown (10YR 4/3) and is 3 to 7 inches thick. The eroded Ap horizon includes material from the A2 horizon and, in most places, from the upper part of the B horizon. The B2t horizon is silty clay loam or heavy silty clay loam.

Lamoni series

The Lamoni series consists of deep, somewhat poorly drained soils that formed in a thin layer of loess and weathered, clayey glacial till. The native vegetation was grass. These soils are on convex side slopes on uplands. Slopes range from 5 to 14 percent. Permeability is slow or very slow.

These soils are a taxadjunct to the Lamoni series because they have chroma of 1 in the lower part of the mollic epipedon and have distinct mottles. The Lamoni soil in map units 822C2, 822D2, and 822D3 does not have a mollic epipedon. These features are not within the defined range for the series, but they do not affect the use or behavior characteristics of these soils.

Lamoni soils are adjacent to Adair, Clarinda, Nira, and Shelby soils. Lamoni soils have a grayer B horizon than Adair soils. They are more sandy and are slightly browner in the upper part of the B horizon than Clarinda soils. They have a more clayey subsoil than Nira and Shelby soils.

Typical pedon of Lamoni silty clay loam, 5 to 9 percent slopes, in pasture on a convex slope, 620 feet west and 300 feet north of southeast corner of sec. 22, T. 77 N., R. 30 W.

A1—0 to 10 inches; black (10YR 2/1) silty clay loam; strong fine granular and very fine subangular blocky structure; common fine sand grains; friable; strongly acid; clear smooth boundary.

A3—10 to 14 inches; black (10YR 2/1) heavy clay loam; few fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6 and 5/8) mottles; moderate to strong fine subangular blocky structure; friable; medium acid; gradual wavy boundary.

IIB1—14 to 21 inches; dark grayish brown (10YR 4/2) light clay; few fine distinct yellowish brown (10YR 5/6) mottles; very dark gray (10YR 3/1) and dark gray (10YR 4/1) coatings on faces of peds; moderate fine subangular blocky structure; firm; many fine sand grains; medium acid; gradual wavy boundary.

IIB21t—21 to 25 inches; grayish brown (2.5Y 5/2) and dark gray (10YR 4/1) light clay; common fine distinct yellowish brown (10YR 5/4 and 5/8) mottles; some very dark gray (10YR 3/1) coatings on faces of peds; moderate fine subangular blocky structure; firm; many fine and medium sand grains; medium acid; clear wavy boundary.

IIB22t—25 to 30 inches; yellowish brown (10YR 5/6 and 5/8) light clay; few medium distinct strong brown (7.5YR 5/6) and common medium distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; firm; many fine and medium sand grains; medium acid; clear wavy boundary.

IIB23t—30 to 40 inches; mottled grayish brown (2.5Y 5/2), yellowish brown (10YR 5/4 and 5/6), and gray (10YR 5/1) light clay; weak medium prismatic structure; firm; many fine to coarse sand grains and some gravel; medium acid; gradual smooth boundary.

IIB24—40 to 56 inches; mottled grayish brown (2.5Y 5/2), yellowish brown (10YR 5/6), and gray (10YR 5/1) clay loam; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; many fine to coarse sand grains and some gravel; medium acid; gradual smooth boundary.

IIB3—56 to 74 inches; mottled mixed light gray (2.5Y N 6/0) and yellowish brown (10YR 5/4 and 5/6) clay loam; weak fine subangular blocky structure; firm; common coarse sand grains; medium acid; gradual smooth boundary.

IIC—74 to 96 inches; yellowish brown (10YR 5/4) clay loam; few coarse distinct light gray (2.5Y N 6/0) mottles; massive; firm; common coarse sand grains and some gravel; medium acid.

The solum is 48 to 74 inches thick. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is light or medium clay loam. The uneroded A1 horizon is 10 to 15 inches thick and is strongly acid to medium acid.

The IIB horizon is 40 to 50 percent clay in the finest part. It is 15 to 30 percent sand and gravel.

Macksburg series

The Macksburg series consists of deep, somewhat poorly drained soils that formed in loess. The native vegetation was grass. These soils are on moderately wide to wide upland divides. Slopes range from 0 to 5 percent.

Macksburg soils are adjacent to Nira, Sharpsburg, and Winterset soils. Macksburg soils have lower chroma,

have more mottles, and are more poorly drained than Nira and Sharpsburg soils. They have higher chroma and are better drained than Winterset soils.

Typical pedon of Macksburg silty clay loam, 0 to 2 percent slopes, in cropland on a broad upland divide, 663 feet south and 678 feet east of northwest corner of NE1/4 sec. 22, T. 74 N., R. 31 W.

Ap—0 to 7 inches; black (10YR 2/1) light silty clay loam; weak medium subangular blocky structure parting to weak fine granular; friable; slightly acid; abrupt smooth boundary.

A12—7 to 14 inches; black (10YR 2/1) silty clay loam; moderate very fine granular structure; friable; medium acid; gradual smooth boundary.

A3—14 to 20 inches; very dark brown (10YR 2/2) silty clay loam; weak fine subangular blocky structure parting to moderate fine granular; friable; strongly acid; gradual smooth boundary.

B1—20 to 25 inches; very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) silty clay loam; moderate very fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

B21t—25 to 36 inches; dark grayish brown (10YR 4/2) and brown (10YR 5/3) heavy silty clay loam; few fine faint dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; firm; thin nearly continuous clay films; few fine hard and soft concretions; strongly acid; gradual smooth boundary.

B22t—36 to 43 inches; olive gray (5Y 5/2) heavy silty clay loam; common fine prominent dark brown (10YR 3/3) and yellowish brown (10YR 5/4) and few fine prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin nearly continuous clay films; few clay flows in pores; many fine hard and few soft concretions; medium acid; gradual smooth boundary.

B3t—43 to 60 inches; olive gray (5Y 5/2) silty clay loam; many fine and medium prominent yellowish brown (10YR 5/4) and few strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; friable; very thin discontinuous clay films; many fine hard and few soft concretions; medium acid; diffuse wavy boundary.

C1—60 to 77 inches; olive gray (5Y 5/2) light silty clay loam; many medium prominent strong brown (7.5YR 5/6) and common yellowish brown (10YR 5/6) mottles; massive with some vertical cleavage; friable; few fine hard and many soft concretions; slightly acid.

The solum is 52 to 74 inches thick. The Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is silty clay loam to light silty clay loam. The A horizon is 16 to 24 inches thick and is slightly acid to strongly acid.

The B21 horizon ranges from 10YR to 2.5Y in hue. The B1 horizon is silty clay loam or heavy silty clay loam. The B2t horizon ranges from silty clay loam to heavy silty clay loam.

The C horizon is slightly acid or neutral.

Nira series

The Nira series consists of deep, moderately well drained soils that formed in grayish-colored, unoxidized loess. The native vegetation was grass. These soils are on plane or convex slopes on uplands. Slopes range from 2 to 14 percent. Permeability is moderately slow.

Nira soils are adjacent to Clarinda, Clearfield, Lamoni, and Sharpsburg soils. Nira soils are less clayey in the B horizon than Clarinda and Lamoni soils. They have a browner B horizon than Clearfield soils. They have more mottles in the B horizon than Sharpsburg soils.

Typical pedon of Nira silty clay loam, 5 to 9 percent slopes, in pasture on a short convex slope, 450 feet north and 1,250 feet east of southwest corner of sec. 17, T. 74 N., R. 31 W.

A1—0 to 10 inches; very dark gray (10YR 3/1) light silty clay loam and some very dark grayish brown (10YR 3/2) in the lower part; moderate fine granular structure; friable; medium acid; clear smooth boundary.

B21—10 to 20 inches; brown (10YR 4/3) silty clay loam and common very dark gray (10YR 3/1); few fine distinct strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; friable; medium acid; clear wavy boundary.

B22t—20 to 26 inches; mottled grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6 and 5/8) silty clay loam; moderate fine and medium subangular blocky structure; friable; thin discontinuous clay films; medium acid; clear wavy boundary.

B31—26 to 33 inches; light olive gray (5Y 6/2) light silty clay loam; common fine prominent strong brown (7.5YR 5/6 and 5/8) and few fine distinct olive (5Y 4/3) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; few fine soft dark oxides; medium acid; clear wavy boundary.

B32—33 to 42 inches; light gray (5Y 6/1) light silty clay loam; many medium prominent yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure; friable; common soft dark iron and manganese concretions; medium acid; clear wavy boundary.

C1—42 to 50 inches; light gray (5Y 6/1) light silty clay loam; common fine and medium prominent yellowish red (5YR 5/6) mottles; massive; friable; slightly acid; clear wavy boundary.

C2—50 to 58 inches; mottled light gray (5Y 6/1) and strong brown (7.5YR 5/6) light silty clay loam; massive; friable; medium acid; clear wavy boundary.

C3—58 to 92 inches; light gray (5Y 6/1) light silty clay loam; common medium and coarse prominent strong brown (7.5YR 5/8) mottles; massive; friable; clear wavy boundary.

The solum is 34 to 48 inches thick. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A horizon is light silty clay loam or silty clay loam. If the A horizon is not eroded, it is 10 to 15 inches thick and is medium acid or slightly acid.

The B21 horizon is mainly dark brown or brown (10YR 3/3 or 4/3). The B horizon is mainly silty clay loam, and the clay maximum is 35 percent. The depth to grayish, deoxidized loess is 16 to 30 inches. The Nira soils in map units 570C2 and 570D2 are taxadjuncts to the Nira series; they do not have a mollic epipedon of sufficient thickness.

Nodaway series

The Nodaway series consists of deep, moderately well drained soils that formed in silty alluvium. The native vegetation was trees, shrubs, and grasses. These soils are on first bottoms parallel to stream and river channels. Old oxbows or non-crossable channels are in some areas. Slopes are 0 to 2 percent. Permeability is moderate.

Nodaway soils are adjacent to Ackmore, Colo, and Kennebec soils. Nodaway soils have a thinner and lighter A horizon than Ackmore, Colo, and Kennebec soils. Unlike Colo and Kennebec soils, Nodaway soils are stratified.

Typical pedon of Nodaway silt loam, 0 to 2 percent slopes, in pasture on a floodplain, 84 feet north of fence and 50 feet west of Nodaway River, 84 feet north and 1,215 feet west of southeast corner of sec. 18, T. 76 N., R. 33 W.

A1—0 to 5 inches; very dark gray (10YR 3/1) silt loam; weak fine granular structure; friable; neutral; clear smooth boundary.

C1—5 to 18 inches; very dark gray (10YR 3/1) silt loam; moderate thin platy structure; friable; some grayish brown (10YR 5/2) strata; some grayish brown (10YR 5/2) particles on sides of plates; neutral; clear smooth boundary.

C2—18 to 44 inches; stratified very dark gray (10YR 3/1) and grayish brown (10YR 5/2) silt loam; moderate fine medium and thick platy structure; friable; few yellowish brown (10YR 5/6) stains; neutral; clear smooth boundary.

C3—44 to 58 inches; stratified very dark gray (10YR 3/1) and grayish brown (10YR 5/2) silt loam; common fine dark reddish brown (5YR 3/4) mottles; moderate thin platy structure; friable; neutral; clear smooth boundary.

C4—58 to 64 inches; stratified black (10YR 2/1) and dark gray (10YR 4/1) silt loam; moderate thin platy structure; friable; some dark gray (10YR 4/1) particles on sides of plates; neutral; clear smooth boundary.

C5—64 to 78 inches; stratified black (10YR 2/1) silt loam; weak thin platy structure; friable; some dark gray (10YR 4/1) particles on sides of plates; few yellowish brown (10YR 5/6) stains; neutral.

The thickness of the solum is the same as that of the A horizon. The A1 or Ap horizon ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). The A horizon is 4 to 10 inches thick and is neutral or slightly acid.

The C horizon is variable in color and generally ranges from grayish brown (10YR 5/2) to very dark gray (10YR 3/1). In some pedons, it has thin strata of black (10YR 2/1). The C horizon is silt loam or silty clay loam. In some pedons, there are thin lenses of sandy loam in the C horizon.

Olmitz series

The Olmitz series consists of deep, moderately well drained or well drained soils that formed in loamy alluvium. The native vegetation was grass. These soils are on alluvial fans and foot slopes. Slopes range from 2 to 9 percent. Permeability is moderately slow.

Olmitz soils are adjacent to Caleb, Dickinson, Gara, Shelby, Ely, and Judson soils. Olmitz soils have a thicker and darker A1 horizon than Caleb, Dickinson, Gara, or Shelby soils. Unlike Caleb soils, they do not have an A2 horizon. They are more sandy and less silty in the B horizon than Ely and Judson soils.

Typical pedon of Olmitz loam, 2 to 5 percent slopes, in cropland on a north-facing foot slope, 2,500 feet north and 75 feet west of southeast corner of sec. 2, T. 75 N., R. 32 W.

Ap—0 to 8 inches; black (10YR 2/1) loam; very weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A12—8 to 17 inches; black (10YR 2/1) loam; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; gradual smooth boundary.

A13—17 to 23 inches; very dark brown (10YR 2/2) light clay loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

A3—23 to 30 inches; very dark grayish brown (10YR 3/2) light clay loam; moderate fine subangular blocky structure; common very dark brown (10YR 2/2) organic coatings on faces of peds; friable; medium acid; gradual smooth boundary.

B1—30 to 40 inches; brown (10YR 4/3) light clay loam; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; common very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid; gradual smooth boundary.

B21—40 to 50 inches; dark brown (10YR 3/3) and some brown (10YR 4/3) light clay loam; weak medium prismatic structure parting to moderate fine subangular blocky; friable; common very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid; gradual smooth boundary.

B3—50 to 72 inches; brown (10YR 4/3) and some dark brown (10YR 3/3) light clay loam; common fine faint dark yellowish brown (10YR 4/4) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; common very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid.

The solum is 52 to 65 inches thick. The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon is loam or light clay loam and is 24 to 32 inches thick. The A3 horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or dark brown (10YR 3/3).

The B2 horizon is light clay loam or clay loam. It is medium acid or slightly acid. The B3 horizon ranges from clay loam to sandy clay loam or loam.

Sharpsburg series

The Sharpsburg series consists of deep, moderately well drained soils that formed in loess. The native vegetation was grass. These soils are on convex ridges and side slopes on uplands and on high benches in valleys. Slopes range from 0 to 14 percent. Permeability is moderately slow.

Sharpsburg soils are adjacent to Adair, Ladoga, Macksburg, Nira, and Shelby soils. Sharpsburg soils are more silty and less sandy than Adair and Shelby soils. They have a thicker A1 horizon than Ladoga soils. They have better internal drainage than Macksburg soils. They have fewer mottles in the subsoil above a depth of 30 inches than Nira soils.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes, in cropland on a south-facing slope, 45 feet east and 2,560 feet north of the southwest corner of sec. 33, T. 76 N., R. 31 W.

Ap—0 to 9 inches; black (10YR 2/1) light silty clay loam; weak medium and fine granular structure; friable; slightly acid; clear smooth boundary.

A12—9 to 14 inches; black (10YR 2/1) light silty clay loam; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

A3—14 to 21 inches; very dark grayish brown (10YR 3/2) and some black (10YR 2/1) silty clay loam; weak coarse and medium subangular blocky structure parting to moderate fine subangular blocky; friable; medium acid; clear smooth boundary.

B21t—21 to 28 inches; brown (10YR 4/3) silty clay loam; many dark brown (10YR 3/3) and few very dark grayish brown (10YR 3/2) coatings on faces of peds; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; thin continuous clay films; medium acid; gradual smooth boundary.

B22t—28 to 34 inches; brown (10YR 4/3) silty clay loam; dark brown (10YR 3/3) coatings on faces of peds; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; thin continuous clay films; medium acid; gradual smooth boundary.

B23t—34 to 41 inches; mottled brown (10YR 4/3), grayish brown (2.5Y 5/2), yellowish brown (10YR 5/4), and dark yellowish brown (10YR 4/4) silty clay loam; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; friable; thin discontinuous clay films; few soft black oxides; medium acid; gradual smooth boundary.

B3t—41 to 50 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/8) silty clay loam; weak coarse prismatic structure; friable; thin continuous clay films; few soft black oxides; medium acid; gradual smooth boundary.

C—50 to 60 inches; light brownish gray silty clay loam; many coarse distinct strong brown (7.5YR 5/6) mottles; massive; friable; common medium and coarse black oxides; medium acid.

The solum is 42 to 65 inches thick. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A3 horizon ranges from black (10YR 2/1) to dark brown (10YR 3/3). The A horizon is light silty clay loam or silty clay loam throughout. In uneroded areas it is 10 to 22 inches thick and is medium acid or slightly acid.

In the B21t and B22t horizons, the inside of the peds is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). The B2t horizon is silty clay loam or heavy silty clay loam; on the average it is more than 35 percent clay. The B3t horizon has mottles that range from light brownish gray (2.5Y 6/2) to grayish brown (2.5Y 5/2) and from brown (10YR 4/3) to yellowish brown (10YR 5/8).

The C horizon ranges from silty clay loam to silt loam.

The Sharpsburg soils in map units 370C2, 370D2, and 675D2 are taxadjuncts to the Sharpsburg series; they do not have a mollic epipedon of sufficient thickness. This difference does not affect the use and behavior characteristics of these soils.

Shelby series

The Shelby series consists of deep, moderately well drained soils that formed in glacial till. The native vegetation was grass. These soils are on convex side slopes and narrow ridges on uplands. Slopes range from 5 to 25 percent. Permeability is moderately slow.

Shelby soils are adjacent to Adair, Clarinda, and Lamoni soils. Shelby soils have a subsoil that is less clayey than and is not so red as that of Adair soils. The subsoil of Shelby soils is less clayey than and not so gray as that of Clarinda and Lamoni soils. Shelby soils have a thicker A1 horizon than Gara soils. Unlike the uneroded Gara soils, they do not have an A2 horizon.

Typical pedon of Shelby clay loam, 9 to 14 percent slopes, 297 feet east and 129 feet south of northwest corner of SW1/4SE1/4NW1/4 sec. 18, T. 76 N., R. 31 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) light clay loam, black (10YR 2/1) or very dark brown (10YR 2/2) crushed, dark gray (10YR 4/1) dry; weak fine granular structure; friable; medium acid; clear smooth boundary.

A3—7 to 11 inches; very dark grayish brown (10YR 3/2) and some very dark brown (10YR 2/2) and dark brown (10YR 3/3) light clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

B21t—11 to 17 inches; dark brown (10YR 3/3) clay loam, very dark brown (10YR 2/2) along channels; moderate fine and very fine subangular blocky structure; firm; thin continuous clay films; few stones and pebbles; strongly acid; clear smooth boundary.

B22t—17 to 23 inches; dark yellowish brown (10YR 4/4) clay loam, very dark brown (10YR 2/2) along channels in the upper part; moderate fine subangular blocky structure; firm; medium continuous clay films; few stones and pebbles; medium acid; clear smooth boundary.

B23t—23 to 34 inches; brown (10YR 4/3) clay loam; few fine faint grayish brown (2.5Y 5/2) and few coarse strong brown (7.5YR 5/6) and reddish yellow (7.5YR 6/8) mottles; weak fine and medium blocky structure; firm; medium continuous clay films; few stones and pebbles; medium acid; gradual smooth boundary.

B3t—34 to 48 inches; brown (10YR 4/3) light clay loam; common medium grayish brown (2.5YR 5/2) and few fine strong brown (7.5YR 5/6) mottles; weak medium and coarse blocky structure; firm; medium prisms; thin continuous clay films on blocky peds in the upper part, discontinuous in the lower part; slightly acid; clear smooth boundary.

C1—48 to 60 inches; mottled grayish brown (2.5Y 5/2) and dark yellowish brown (10YR 4/4) clay loam; massive; firm; thin discontinuous clay films on vertical faces of peds; few stones and pebbles; common white soft to very hard carbonate nodules less than 1/4 inch in diameter; calcareous; gradual smooth boundary.

C2—60 to 72 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) clay loam; massive; friable; few stones and pebbles; calcareous; gradual smooth boundary.

The solum is 30 to 60 inches thick. The A horizon ranges from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It ranges from loam to light clay loam or silt loam. It is 9 to 14 inches thick and is medium acid or slightly acid.

The B2t horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). It is clay loam and has a maximum clay content of 35 percent. The B3t horizon is clay loam or light clay loam.

The C horizon is calcareous beginning at a depth between 30 and 60 inches.

The Shelby soils in map units 24C2, 24D2, 24E2, 24F2, 93D2, and 93E2 are taxadjuncts to the Shelby series because they do not have a mollic epipedon. This difference does not affect the use and behavior characteristics of these soils.

Sogn series

The Sogn series consists of shallow, somewhat excessively drained soils that formed in loamy material overlying limestone bedrock. The native vegetation was grass. These soils are on uplands adjacent to the valley of the Middle River. Slopes range from 25 to 40 percent. Permeability is moderate.

These soils are a taxadjunct to the Sogn series because the climate is more moist and the slopes are steeper than is defined in the range for the series. These differences, however, do not affect the use and behavior characteristics of these soils.

Sogn soils are adjacent to Clinton and Gara soils. They are the only shallow soils in Adair County.

Typical pedon of Sogn silty clay loam in an area of Sogn soils, 25 to 40 percent slopes, in pasture on a north-facing slope, 750 feet east and 1,300 feet south of the northwest corner of sec. 25, T. 76 N., R. 30 W.

A1—0 to 9 inches; black (10YR 2/1) silty clay loam; moderate fine and medium granular structure; friable; neutral; clear wavy boundary.

C—9 to 16 inches; 80 to 90 percent limestone fragments; dark silty clay loam soil material in cracks and crevices; calcareous; abrupt wavy boundary.

R—16 inches; hard, fractured limestone bedrock.

The thickness of the solum and the depth to limestone range from 4 to 16 inches. The A1 horizon is black

(10YR 2/1) or very dark gray (10YR 3/1). It ranges from silty clay loam to silt loam or loam. It is 4 to 10 inches thick and is neutral or calcareous. The C horizon is 60 to 95 percent limestone fragments and is 3 to 10 inches thick. The R layer is at a depth between 7 and 20 inches.

Vesser series

The Vesser series consists of deep, somewhat poorly drained or poorly drained soils that formed in silty alluvium. The native vegetation was grass. These soils are on high bottom lands, fans, and foot slopes. Slopes range from 0 to 5 percent. Permeability is moderate.

Vesser soils are adjacent to Ackmore, Colo, Humeston, Kennebec, and Nodaway soils. Vesser soils have a lighter colored and less clayey B horizon than Humeston soils. Unlike Ackmore, Colo, Kennebec, and Nodaway soils, they have an A2 horizon. Unlike Nodaway soils, they are not stratified.

Typical pedon of Vesser silt loam, 0 to 2 percent slopes, in cropland on bottom lands, 27 feet south of fence and 72 feet west of northwest corner of sec. 27, T. 76 N., R. 30 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) heavy silt loam; weak fine and medium granular structure; very friable; neutral; clear smooth boundary.

A12—8 to 15 inches; black (10YR 2/1) heavy silt loam; few fine distinct dark reddish brown mottles; very weak thin platy structure parting to weak fine subangular blocky; very friable; slightly acid; clear smooth boundary.

A21—15 to 24 inches; dark gray (10YR 4/1) and very dark gray (10YR 3/1) silt loam; few fine distinct brown (7.5YR 4/2) mottles; weak very thin platy structure parting to weak very fine subangular blocky; very friable; medium acid; gradual smooth boundary.

A22—24 to 33 inches; dark gray (10YR 4/1) and very dark gray (10YR 3/1) silt loam; few fine faint brown (7.5YR 4/2) mottles; weak thin platy structure parting to weak fine subangular blocky; very friable; medium acid; clear smooth boundary.

B21tg—33 to 36 inches; dark gray (10YR 4/1) light silty clay loam; common fine distinct reddish brown (5.5YR 4/4) mottles; moderate medium prismatic structure parting to weak fine and medium subangular blocky; friable; discontinuous very dark gray (10YR 3/1) organic clay films; common black (10YR 2/1) organic accumulations in old root channels; few black oxides; some gray (10YR 5/1) silt coatings on faces of peds; medium acid; gradual smooth boundary.

B22tg—36 to 41 inches; dark gray (10YR 4/1) silty clay loam; common fine distinct brown (7.5YR 4/4) mottles; moderate medium prismatic structure parting to weak fine and medium subangular blocky; friable; discontinuous very dark gray (10YR 3/1) organic clay films; few black oxides; medium acid; gradual smooth boundary.

B23tg—41 to 49 inches; dark gray (10YR 4/1) silty clay loam; common medium distinct brown (7.5YR 4/4) mottles; moderate medium prismatic structure parting to weak fine and medium subangular blocky; friable; thin discontinuous clay films; black organic clay flows in old root channels; medium acid; gradual smooth boundary.

B31tg—49 to 65 inches; dark gray (10YR 4/1) and gray (10YR 5/1) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; friable; moderately thick black discontinuous organic clay flows in old root channels; medium acid.

The solum is 60 to 80 inches thick. The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is heavy silt loam or light silty clay loam. The A horizon is 12 to 20 inches thick and is medium acid to neutral. The A2 horizon ranges from very dark gray (10YR 3/1) to gray (10YR 5/1). It is 12 to 18 inches thick.

The B2 horizon ranges from dark gray (10YR 4/1) to gray (10YR 5/1) and has darker colored coatings on faces of peds. It is light silty clay loam to medium silty clay loam.

Winterset series

The Winterset series consists of deep, poorly drained soils that formed in loess. The native vegetation was grass. These soils are on broad upland divides. Slopes are 0 to 2 percent. Permeability is slow or moderately slow.

Winterset soils are adjacent to Macksburg and Sharpsburg soils. They have grayer B2 and B3 horizons than Macksburg and Sharpsburg soils.

Typical pedon of Winterset silty clay loam, 0 to 2 percent slopes, in cropland on a broad upland divide, 1,520 feet west and 1,600 feet north of southeast corner of sec. 24, T. 77 N., R. 30 W.

Ap—0 to 7 inches; black (10YR 2/1) light silty clay loam; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

A12—7 to 16 inches; black (10YR 2/1) light silty clay loam; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; gradual smooth boundary.

B1—16 to 23 inches; very dark gray (10YR 3/1) heavy silty clay loam, dark gray (10YR 4/1) crushed; few fine distinct olive brown (2.5Y 4/4) mottles; moder-

ate very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21tg—23 to 31 inches; dark gray (10YR 4/1) light silty clay; common fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure parting to moderate very fine subangular blocky; firm; medium acid; gradual smooth boundary.

B22tg—31 to 40 inches; grayish brown (2.5Y 5/2) and gray (5Y 6/1) heavy silty clay loam; many medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; dark gray (10YR 4/1) coatings on peds; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; medium acid; gradual smooth boundary.

B3tg—40 to 61 inches; gray (5Y 6/1) silty clay loam; many moderate and coarse distinct yellowish brown (10YR 5/6 and 5/8) mottles; dark gray (10YR 4/1) and gray (10YR 5/1) coatings on peds in upper part of horizon; moderate fine prismatic structure in upper part and very weak fine prismatic structure in lower part; friable; common fine soft dark oxides; common dark organic coatings in root channels; slightly acid; gradual smooth boundary.

Cg—61 to 72 inches; gray (5Y 6/1) light silty clay loam; many medium and coarse distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive; friable; common fine soft dark oxides; common dark organic coatings in root channels.

The solum is 54 to 70 inches thick. The A1 horizon is black (10YR 2/1 or N 2/0). The A horizon is light silty clay loam or medium silty clay loam. It is 14 to 20 inches thick and ranges from medium acid to slightly acid.

The B1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). The B2 horizon ranges in hue from 10YR to 2.5Y or 5Y. It is heavy silty clay loam or light silty clay. The B3 horizon also ranges in hue from 10YR to 2.5Y or 5Y. It ranges from light silty clay loam to silty clay loam.

Zook series

The Zook series consists of deep, poorly drained soils that formed in silty and clayey alluvium. The native vegetation was grass. These soils are on low, flat flood plains and in drainageways. Slopes range from 0 to 5 percent. Permeability is slow.

These soils are a taxadjunct to the Zook series because they do not have mottles in the lower part of the mollic epipedon and do not have mottles or the colors defined for the series directly below the mollic epipedon. These differences do not affect the use and behavior characteristics of these soils.

Zook soils are adjacent to Colo, Ackmore, Kennebec, and Nodaway soils. Zook soils are darker in color and are more clayey in the A and B horizons than Kennebec and Nodaway soils. They differ from Colo and Ackmore soils in not having a buried soil horizon.

Typical pedon of Zook silty clay loam, 0 to 2 percent slopes, in pasture on a creek bottom, 520 feet west and 400 feet north of southeast corner of sec. 36, T. 75 N., R. 31 W.

Ap—0 to 4 inches; black (10YR 2/1) silty clay loam; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

A12—4 to 14 inches; black (N 2/0) silty clay loam; moderate fine granular structure; friable; medium acid; clear smooth boundary.

A13—14 to 23 inches; black (N 2/0) heavy silty clay loam; moderate fine and very fine subangular blocky structure; firm; indefinite sheen on faces of peds; slightly acid; gradual smooth boundary.

A3—23 to 30 inches; black (10YR 2/1) light silty clay; weak medium prismatic structure parting to moderate fine and medium angular blocky; firm; definite sheen on faces of peds; slightly acid; gradual smooth boundary.

B1g—30 to 40 inches; very dark gray (10YR 3/1) light silty clay; weak medium prismatic structure parting to moderate fine and very fine angular blocky; firm; definite sheen on faces of peds; slightly acid; gradual smooth boundary.

B2g—40 to 51 inches; very dark gray (10YR 3/1) light silty clay; weak medium prismatic structure parting to moderate fine angular blocky; firm; definite sheen on faces of peds; slightly acid; gradual smooth boundary.

B3g—51 to 64 inches; dark gray (10YR 4/1) and very dark gray (10YR 3/1) heavy silty clay loam; weak medium prismatic structure parting to moderate fine angular blocky; firm; definite sheen on faces of peds; some black (10YR 2/1) clay balls 1/2 to 1 inch in diameter; neutral; gradual smooth boundary.

The solum is 44 to 64 inches thick. The A horizon is black (N 2/0 or 10YR 2/1). It ranges from silty clay loam to light silty clay. It is 26 to 38 inches thick and is medium acid to slightly acid.

The B horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) above a depth of 40 inches. It is heavy silty clay loam or light silty clay in the zone of maximum clay content. The B horizon is 10 to 40 inches thick and ranges from medium acid to neutral.

Formation of the soils

In this section, the factors that have affected soil formation in Adair County are described. This section can be useful to scientists, teachers, students, and others interested in the formation and classification of soils. A detailed description of the profile considered representa-

tive of each soil series is included in the section, "Soil series and morphology."

Factors of soil formation

A soil is produced through the action of soil-forming processes on material deposited or accumulated by geologic agencies. The characteristics of a soil at any given time are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the processes of soil formation have acted on the soil material.

Climate and vegetation are the active factors in soil formation. They act on parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. Parent material also affects the kind of soil that is formed and, in extreme cases, determines it almost entirely. And time is required to change the parent material into soil. A long period of time generally is required for distinct horizons to develop.

The effects of the five factors of soil formation are so closely interrelated that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are not known.

Parent material

The soils of Adair County formed in four kinds of geologic material. Listed in the order of their influence, these are loess, glacial till, alluvium, limestone, and eolian sand. The relationship of some of the major soils to their parent material is shown in figures 1,2,3,4, and 5.

In Adair County, the various deposits and subsequent geologic erosion have resulted in a landscape that is characterized by broad, stable ridgetops, gently sloping to steep side slopes, and numerous large and small stream valleys. The soils on ridgetops formed in loess, the soils on steep side slopes formed in glacial till and limestone, and the soils in valleys formed in alluvium. A detailed study has been made of the landscape evolution and soil formation in the county by R. V. Ruhe, R. B. Daniels, and J. G. Cady (*21*).

Loess—Loess is silty wind-deposited material. It consists largely of silt particles and has a smaller amount of clay and sand. Loess is the most extensive parent material in Adair County. It was deposited during the Wisconsin glacial period, from about 24,500 to 14,000 years ago (*15,19*). It is believed to have been blown mainly from the flood plain of the Missouri River along the western boundary of Iowa (*6*). The thickness of the loess deposits and the differences between the soils that formed in loess are related to the distance of these soils from the source of the loess. The loess in Adair County is about 12 to 18 feet thick on the nearly level, stable divides (*24*). It is thinner on the side slopes, and on the higher uplands it has been completely removed by erosion, exposing the glacial till.

In the southwestern and southern parts of Iowa, the loess gradually thins and becomes finer textured from west to east. The range in texture is not great in Adair County.

The most extensive soils in Adair County that formed in loess are the Ladoga, Macksburg, Nira, and Sharpsburg soils. Clearfield, Clinton, and Winterset soils also formed in loess but are less extensive.

Many studies have been done on the loess and the soils that formed in loess in western and southwestern Iowa. Ruhe and others (*3,14,19,21*) have studied the relationship of loess to topography in western Iowa. Davidson and associates (*4*) studied the physical and engineering properties of loess in western Iowa and elsewhere. Ulrich (*26,27*) studied physical and chemical changes accompanying soil profile formation in soils formed in loess, including Winterset soils, in southwest Iowa. Other chemical and physical data have been reported on Macksburg, Sharpsburg, and Winterset soils (*22,29*).

Glacial till—Two glaciers, the Nebraskan and, later, the Kansan, have deposited material in Adair County. Nebraskan till is not identifiable on the landscape in Adair County but can be seen in a few deep cuts in the southwestern part. Kansan till is exposed throughout the county. In steep areas in the southern part, it forms an extensive part of the landscape. Unweathered till is firm, calcareous clay loam. It consists of pebbles, boulders, and sand as well as silt and clay. This till is a heterogeneous mixture that shows little evidence of sorting or stratification. The mineral composition of the components of this till also is heterogeneous (*11*) and is similar to that of particles of unweathered loess.

The glacial deposits in Adair County are 6 to 12 feet thick in areas where limestone and shale crop out but range to 100 feet or more in thickness in the southern part of the county. The thickness, hardness, or absence of underlying sediment or rock apparently has had a direct effect on the thickness of the glacial till.

Soils had formed on the Kansan till plain during the Yarmouth and Sangamon interglacial periods, before the loess was deposited (*21*). In nearly level areas, these soils were strongly weathered and had a gray, plastic subsoil called gumbotil (*9,10,16, 21*). This gumbotil is several feet thick and has very slow permeability. A widespread erosion surface has cut below the Yarmouth-Sangamon paleosol into the Kansan till and older deposits. The surface generally is characterized by a stone line or subadjacent sediment and is surmounted by pedisediment (*16,17,18,19,20*). A paleosol formed in the pedisediment stone line and, generally, in the subadjacent till.

This surface is referred to as Late Sangamon. The paleosol was less strongly weathered, more reddish in color, and not so thick as that in the nearly level areas.

The soils that formed in Kansan till during the Yarmouth and Sangamon periods were covered by loess. Geologic erosion has removed this loess in many sloping areas and has exposed the paleosol. In places, the paleosol has been beveled or truncated so that only the lower part of the strongly weathered paleosol remains. This erosion took place prior to loess deposition, about 25,000 years ago or more (*21*). In other places, erosion has removed all of the paleosol and has exposed till that is only slightly weathered at the surface. This erosion occurred mainly in post-glacial times.

Clarinda soils formed in the Yarmouth-Sangamon paleosol of strongly weathered, gray clay. Lamoni soils formed in the truncated Yarmouth-Sangamon paleosol. The clay layer in Lamoni soils is not so thick as that in Clarinda soils. Adair and Armstrong soils formed in areas where the less strongly weathered, reddish paleosol is exposed. Gara and Shelby soils formed in slightly weathered glacial till.

Caleb soils formed in pre-Sangamon erosional sediment of variable texture and of glacial origin. This sediment appears to have been angularly truncated in many places, commonly resulting in an irregular mixture of material of contrasting textures. Caleb soils are on extended, stepped interfluves upslope from the present drainage system. The landscape in areas of Caleb soils is partly influenced by valley fill, but the surface blends with the present erosional uplands. These soils are higher in elevation than the soils on the modern flood plains, but they are lower than Gara and Shelby soils. Caleb soils are downslope from that part of the interfluves that has been truncated in Recent (Wisconsin) time.

Alluvium—Alluvium consists of sediment that has been deposited along major and minor streams and drainageways as well as on benches. It varies widely in texture because the material from which the alluvium was derived and the manner in which it was deposited differ. In Adair County, alluvium has derived mainly from loess, glacial till, and layers of exposed shale. On narrow stream bottoms and on foot slopes along the Middle River, fragmented limestone has been washed down from steep side slopes. These fragments formed a flaggy substratum over which the silty and loamy alluvium was later deposited.

Alluvial material that has been transported only a short distance is called local alluvium. This alluvium retains many of the characteristics of the soils from which it has washed. Judson soils, for example, generally are at the base of slopes below soils that formed in loess. They are silty and are similar in texture to the soils upslope. Olmitz soils also formed in local alluvium, but they are downslope from till-derived soils. They are more sandy than Judson soils because the alluvium in which they formed was derived from sandier soils. Ely soils also formed in local alluvium.

When rivers and streams overflow, coarse textured or sandy material is deposited first on the soils adjacent to the stream channel. As the water spreads slowly toward the uplands, the silt and very fine sand are deposited. When floodwaters are high, the water spreads slowly toward the edge of the flood plain, carrying particles of very fine silt and clay. As the floodwaters recede, these particles settle and are mixed with fine particles of the local alluvium.

This pattern is evident in many places on wider stream bottoms of the North, Middle, and Grand Rivers. In these areas, alluvial land is located nearest to the streams. Nodaway soils are next, and then Kennebec soils. Nodaway soils mainly consist of coarse silt but also have some fine sand and clay. Kennebec soils are more silty and clayey and less sandy than Nodaway soils. Colo and Zook soils are located farther from the main channel. They are the finest textured, most poorly drained soils, and they are somewhat lower in elevation than the other soils.

Some benches or second bottoms are along the main streams in the northeastern and southwestern parts of the county. In these areas, loess-covered benches have formed over the underlying sandy alluvium. Sharpsburg, bench, and Ladoga, bench, soils are not so subject to flooding as Kennebec and Nodaway soils, and they have more profile development. In some areas, streams are still cutting into limestone, and the flood plains are narrower.

Limestone—The oldest parent material in the county is limestone. Beds of limestone were deposited during a sedimentary cycle in the Pennsylvanian Period. These limestone beds are on side slopes of the Middle River Valley in the eastern part of Adair County. These areas are included in the map unit of Sogn soils or are shown on the detailed maps as rock outcrops.

Sandstone is not exposed in Adair County except for one place in a road cut in the northwestern part.

Eolian (windblown) sand consists mainly of fine quartz sand that, in Adair County, is mixed with some silt. It has been blown from stream bottoms and deposited on nearby ridgetops and side slopes. Most areas of eolian sand are minor in extent and are shown on the soil maps by a spot symbol. Small areas of eolian sand are included in the mapping of Dickinson soils.

Climate

The climate in Adair County, according to recent evidence, has been variable. Walker (*31*) concluded in recent studies that in the post-Cary glaciation, which occurred between 13,000 and 10,500 years ago, the climate was cool and the vegetation was dominantly conifers. However, between 10,500 and 8,000 years ago, a warming trend occurred, and the vegetation changed

from conifers to mixed forest in which hardwoods were prominent. Beginning about 8,000 years ago, the climate became still warmer and also drier. At this time, herbaceous prairie plants became dominant and have remained dominant up to the present. McComb and Loomis (*12*), in studies made of the transition from forest to prairie in central Iowa, concluded that a late change occurred in post-glacial climate. The climate changed from relatively dry prairie to a moderately moist climate. Walker's evidence indicates that this change may have begun about 3,000 years ago. The present climate is midcontinental subhumid.

The climate is nearly uniform throughout the county. However, in areas where soils are developing, the influence of the general climate on soil formation is modified by local conditions. For example, the soils on south-facing slopes have a microclimate that is warmer and less humid than the climate of nearby areas. Low-lying, poorly drained soils on bottoms have a wetter and colder microclimate than most of the surrounding soils.

The general climate in the survey area has had an important overall influence on the characteristics of the soils but has not caused significant differences among them. However, local climatic differences can influence soil characteristics within the same climatic region.

Changes in temperature activate the weathering of parent material by water and air. Weathering results in changes caused by physical and chemical actions. Rainfall has influenced soil formation through its effect on the amount of leaching that occurs and on the kind of plants that grow. Some variations in plant and animal life are caused by variations in temperature or by the action of other climatic forces on the soil material; in this way climate influences the soils through changes that are brought about by differences in plant and animal populations.

Plants and animals

Many kinds of living organisms, including burrowing animals, worms, crayfish, and micro-organisms, affect soil development. Differences in the kind of vegetation commonly cause the most marked differences among soils (*13*).

The soils in Adair County have been influenced in recent times by two main types of vegetation—prairie grasses and trees. The main prairie grasses were big bluestem and little bluestem, and the trees were mainly deciduous—oak, hickory, ash, and elm.

When the county was settled, tall prairie grasses were the dominant vegetation on the broad, nearly level to gently rolling uplands. About 70,000 acres in the survey area was in trees at the time of settlement. Trees were growing near most major streams and their major tributaries.

Soils that formed under prairie vegetation typically have a thicker, darker surface layer than soils that formed under trees because grasses have many roots and tops that have decayed on or in the soil. The organic matter in soils that formed under trees was derived mainly from leaves that were deposited on the surface of the soil. Soils that formed under trees generally are more acid and have had more leaching of bases and clay minerals.

Sharpsburg and Macksburg soils are typical of soils that formed in loess under prairie vegetation. Shelby soils are typical of soils that formed in glacial till under grasses.

Clinton soils in Adair County formed in loess under forest vegetation. These soils have a thin, light-colored A1 horizon; a prominent, gray A2 horizon that is very distinct when dry; and a B horizon that has stronger structure and shows more evidence of the accumulation of silicate clay than that of soils that formed under prairie vegetation.

Ladoga and Gara soils, however, have properties that are intermediate between those of soils that formed entirely under trees and those of soils that formed under grass. Ladoga and Gara soils are believed to have formed under prairie grasses and later were covered by trees. Their morphology reflects the influence of both trees and grass.

Relief

Relief in Adair County ranges from nearly level to very steep. It is important to soil formation because it affects drainage, runoff, the height of the water table, and erosion.

In soils that formed in the same parent material, the influence of relief can be seen in differences in color, thickness of the solum, and horizonation. For example, Winterset and Macksburg soils formed in loess under similar vegetation but in different landscape positions. Winterset soils are very poorly drained and are in level areas where water is ponded. Sharpsburg soils are moderately well drained and have slopes that cause some runoff. The water that does not run off either percolates to a lower depth or evaporates. Water that percolates through the soil removes clay from the A horizon, most of which accumulates in the B horizon. The content of clay in the B horizon generally is greater in gently sloping or level soils than in steep soils. It is progressively higher in Sharpsburg, Macksburg, and Winterset soils. The clay content of Winterset and Sharpsburg soils has been reported in detail by Ulrich (*26,27*) and Hutton (*6,7*).

Relief affects the color of the B horizon through its effect on drainage and soil aeration. The subsoil in a well drained soil generally is brown because the iron compounds are well distributed throughout the horizon and are oxidized. The subsoil in soils that have restricted drainage generally is grayish in color and is mottled. Sharpsburg soils are sloping and have a brownish-col-

ored B horizon. Winterset soils are in level areas and have a grayish-colored B horizon.

In soils that have a wide range of slope and landscapes, for example, Shelby soils, the depth to carbonates decreases as the slope increases and as slopes are more convex.

Slope affects runoff, and the amount of runoff affects the amount of moisture available for plants. In places, insufficient moisture has restricted plant growth on some of the steeper Shelby and Sharpsburg soils. This results in differences in the thickness and organic matter content of the surface layer between these soils and the less sloping Shelby and Sharpsburg soils.

Time

The passage of time enables relief, climate, and plants and animals to change the parent material. However, soil development generally is interrupted by geologic events that expose new parent material. In Adair County, at least three kinds of parent material have affected soil formation on uplands (*24*).

Bedrock was covered twice by glacial drift. After that, the present surface soil material, consisting of loess, was deposited. These changes have caused soils to be buried, thus stopping further development of those soils.

According to Ruhe (*21*), Clarinda, Lamoni, Adair, and Armstrong soils have subsoil horizons that are among the most weathered in the county. These soils formed in Kansan till, and weathering began in Yarmouth and Sangamon times. After that, they were covered by loess. In more recent times, this loess was removed through erosion, and the material in the upper part of the ancient subsoil was again exposed to weathering. The Clarinda, Lamoni, Adair, and Armstrong soils are referred to as paleosols. The glacial till in these soils is underlain by beds of limestone, which also have been exposed. Sogn soils formed in material derived from the limestone beds.

The radiocarbon technique for determining the age of carbonaceous material has been used to date soils that formed partly in loess and till of Wisconsin age (*14,20*). Loess deposition is believed to have begun about 25,000 years ago and continued until about 14,000 years ago (*5,19*). Based on these dates, the surface of the nearly level, loess-mantled divides in Iowa is about 14,000 years old. In Adair County, the nearly level divides and most of the gently sloping divides are in these stable areas. The soils on these divides include Winterset, Macksburg, and Sharpsburg soils. Geologic erosion has beveled and, in places, removed material on side slopes, and the sediment has been deposited downslope (*21*). The surface of the nearly level upland divides is older than that of the slopes that bevel and ascend to the divides. Thus, the soils on side slopes, including Gara and Shelby soils, are believed to be less than 14,000 years old.

The sediment from side slopes accumulated on soils downslope as local alluvium. The age of the soils on side slopes is determined by dating the alluvial fill at the base of these slopes. Studies by Ruhe, Daniels, and Cady (*21*) indicate that this alluvial fill is about 6,800 years old. Daniels and Jordon (*3*) determined that the alluvium in some stream valleys in western Iowa is less than 1,800 years old. Because this alluvium consists of sediment that washed from the side slopes, the surface of the side slopes is as young or younger than the local alluvium. Soils in Adair County that formed in local alluvium include Ely, Judson, Kennebec, Olmitz, and Zook soils. Nodaway soils also formed in alluvium, some of which has been deposited since settlement by man.

Man's influence on the soils

Human activity has significantly changed the soils in Adair County. During settlement, the prairie sod was broken and the timber was cleared, thus removing and changing the protective cover.

Water erosion has caused the most apparent changes. As the soils were cultivated, surface runoff increased and the rate of water infiltration decreased. As a result, erosion was accelerated. Today, erosion has removed part or all of the original surface layer of the sloping soils under cultivation. In places, shallow to deep gullies have formed.

Erosion also has affected the structure and consistence of the surface layer of cultivated soils. The plow layer of severely eroded soils commonly consists partly of material from the upper part of the subsoil. This subsoil material is less friable and finer textured than that in the original surface layer.

Erosion and cultivation also reduce the organic matter content and fertility of the soils. Compaction by heavy machinery reduces the thickness of the surface layer and changes its structure. The granular structure of the soils in native grassland breaks down if the soils are cropped intensively.

Man also has done much to increase soil productivity, to decrease soil loss, and to reclaim areas not suitable for crops or as pasture. For example, terraces, erosion-control structures, and other management practices have helped to slow or control runoff and erosion. Diversions at the base of slopes and drainage ditches have helped to prevent flooding and deposition, thus making large areas of bottom lands suitable for cultivation. The productivity of the soils has been increased through the use of commercial fertilizer and lime.

Processes of horizon differentiation

Horizons are differentiated in a soil through the action of four basic processes: additions, removals, transfers, and transformations of many of the substances in the soils (*23*). These processes affect the organic matter,

soluble salts, carbonates, sesquioxides, or silicate clay minerals in a soil.

In general, these processes tend to promote horizon differentiation; however, some tend to offset or retard it. These processes and the changes that result proceed simultaneously, and the profile that is formed is determined by the balance of these changes within the profile.

In most soils, one of the first steps in the process of horizon differentiation is the accumulation of organic matter. The organic matter content in the A1 horizon of the soils in Adair County ranges from high to very low. Clinton soils, for example, have a thin A1 horizon that is low in organic matter. Winterset and Colo soils have a thick A1 horizon that is high in organic matter. The organic matter content of some soils was originally high but is now low because of erosion.

The removal of substances from part of the soil profile also affects the differentiation of soil horizons. For example, calcium carbonates and bases move downward through the soil and accumulate in the lower part of the profile. Except for the severely eroded soils, the calcium carbonate in the soils in Adair County has been leached completely from the upper part of the profile. Some soils have been so strongly leached that their subsoil is strongly acid or very strongly acid.

Substances can also be transferred from one horizon to another. Phosphorus in the subsoil is absorbed by plant roots and distributed to parts of the plant above the ground. When the plant dies, phosphorus is added to the surface layer as the plant residue decays.

The translocation of silicate clay minerals also is an important process in horizon differentiation. Clay minerals from the A horizon are carried downward in suspension by percolating water. They accumulate in the B horizon in pores and root channels and as clay films on faces of peds. This process has influenced the profile of many of the soils in Adair County. However, in some soils, the clay content of the A horizon is not markedly different from that of the B horizon, and other evidence of clay translocation is minimal.

Another kind of transfer is brought about by shrinking and swelling. Shrinking and swelling causes cracks in the soil, and material from the surface layer moves through these cracks into a lower part of the profile. This kind of physical transfer is minimal in most soils but occurs to some extent in very clayey soils, for example, Clarinda soils.

The process of transformation can be physical or chemical. The weathering of soil particles to a smaller size is an example of physical transformation. The reduction of iron, or gleying, is an example of a chemical transformation. It involves the saturation of a soil by water for a long period in the presence of organic matter. Gleying is characterized by ferrous iron and gray colors in the soil. It is associated with poorly drained soils, for example, Winterset soils. The content of reductive extractable iron, or free iron, typically is lower in somewhat poorly drained soils, for example, Macksburg soils (*29*). Another kind of transformation is the weathering of primary apatite mineral in the parent material to secondary phosphorous compounds.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Conservation tillage. A method of preparing a seedbed with a minimum of soil disturbance. It includes leaving enough crop residue on the surface to protect the soil.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of

oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Linear area of seepage. An area where the soil remains wet after the surrounding soils have dried out. These areas are on sidehills at the loess-till contact. They form during wet periods, and the soil is kept wet by a water table that is perched over the glacial till.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse* more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction be-

cause it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.
Water table, apparent. A thick zone of free water in

the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

Month	Temperature[1]						Precipitation[1]				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[2]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	29.6	10.5	20.1	56	-20	0	.85	.26	1.32	3	6.5
February---	36.0	16.2	26.1	63	-14	0	1.23	.27	1.98	3	5.9
March------	45.8	24.9	35.4	78	-4	37	2.21	.87	3.28	5	5.8
April------	62.5	38.2	50.4	86	16	109	3.24	1.75	4.45	7	1.1
May--------	73.4	49.9	61.6	95	29	367	4.41	2.56	5.90	7	.0
June-------	81.9	59.2	70.6	95	42	618	4.56	2.74	6.19	7	.0
July-------	86.4	64.0	75.2	99	47	781	3.91	1.51	5.84	6	.0
August-----	84.3	61.7	73.1	97	46	716	3.75	1.99	5.19	6	.0
September--	76.2	52.7	64.5	93	33	435	4.10	1.74	6.01	6	.0
October----	66.0	40.9	53.5	87	20	287	2.36	.82	3.60	5	.1
November---	48.8	28.5	38.6	73	2	10	1.47	.47	2.26	3	2.8
December---	35.2	17.1	26.1	60	-12	0	.93	.33	1.40	3	5.2
Year-----	60.5	38.7	49.6	99	-21	3,360	33.02	26.03	39.62	61	27.4

[1]Recorded in the period 1951-74 at Greenfield, Iowa.

[2]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature[1]		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 24	April 29	May 15
2 years in 10 later than--	April 19	April 25	May 10
5 years in 10 later than--	April 9	April 17	May 1
First freezing temperature in fall:			
1 year in 10 earlier than--	October 16	October 4	September 25
2 years in 10 earlier than--	October 21	October 9	September 30
5 years in 10 earlier than--	October 30	October 19	October 10

[1]Recorded in the period 1951-74 at Greenfield, Iowa.

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	184	164	143
8 years in 10	191	171	150
5 years in 10	203	184	162
2 years in 10	215	197	174
1 year in 10	222	204	181

[1]Recorded in the period 1951-74 at Greenfield, Iowa.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
8B	Judson silty clay loam, 2 to 5 percent slopes	1,017	0.3
8C	Judson silty clay loam, 5 to 9 percent slopes	482	0.1
11B	Colo-Ely silty clay loams, 2 to 5 percent slopes	47,613	13.1
13B	Vesser-Nodaway silt loams, 2 to 5 percent slopes	876	0.2
24C	Shelby clay loam, 5 to 9 percent slopes	322	0.1
24C2	Shelby clay loam, 5 to 9 percent slopes, moderately eroded	1,332	0.4
24D	Shelby clay loam, 9 to 14 percent slopes	1,512	0.4
24D2	Shelby clay loam, 9 to 14 percent slopes, moderately eroded	37,115	10.2
24E	Shelby clay loam, 14 to 18 percent slopes	728	0.2
24E2	Shelby clay loam, 14 to 18 percent slopes, moderately eroded	17,384	4.8
24F2	Shelby clay loam, 18 to 25 percent slopes, moderately eroded	1,454	0.4
51	Vesser silt loam, 0 to 2 percent slopes	1,215	0.3
54	Zook silty clay loam, 0 to 2 percent slopes	3,580	1.0
54+	Zook silt loam, overwash, 0 to 2 percent slopes	1,200	0.3
69C	Clearfield silty clay loam, 5 to 9 percent slopes	3,187	0.9
69C2	Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded	445	0.1
76B	Ladoga silt loam, 2 to 5 percent slopes	881	0.2
76C	Ladoga silt loam, 5 to 9 percent slopes	2,376	0.7
76C2	Ladoga silt loam, 5 to 9 percent slopes, moderately eroded	4,870	1.3
76D	Ladoga silt loam, 9 to 14 percent slopes	758	0.2
76D2	Ladoga silt loam, 9 to 14 percent slopes, moderately eroded	2,272	0.6
80C	Clinton silt loam, 5 to 9 percent slopes	562	0.2
80D2	Clinton silt loam, 9 to 14 percent slopes, moderately eroded	853	0.2
80E2	Clinton silt loam, 14 to 18 percent slopes, moderately eroded	395	0.1
93D2	Shelby-Adair clay loams, 9 to 14 percent slopes, moderately eroded	8,352	2.3
93E2	Shelby-Adair clay loams, 14 to 18 percent slopes, moderately eroded	3,044	0.8
133	Colo silty clay loam, 0 to 2 percent slopes	4,212	1.2
133+	Colo silt loam, overwash, 0 to 2 percent slopes	1,660	0.5
175C2	Dickinson fine sandy loam, 5 to 9 percent slopes, moderately eroded	313	0.1
175D2	Dickinson fine sandy loam, 9 to 14 percent slopes, moderately eroded	536	0.1
179D	Gara loam, 9 to 14 percent slopes	397	0.1
179D2	Gara loam, 9 to 14 percent slopes, moderately eroded	3,356	0.9
179E2	Gara loam, 14 to 18 percent slopes, moderately eroded	9,170	2.5
179F2	Gara loam, 18 to 25 percent slopes, moderately eroded	2,465	0.7
192C2	Adair clay loam, 5 to 9 percent slopes, moderately eroded	1,723	0.5
192D2	Adair clay loam, 9 to 14 percent slopes, moderately eroded	4,520	1.2
212	Kennebec silt loam, 0 to 2 percent slopes	2,904	0.8
220	Nodaway silt loam, 0 to 2 percent slopes	2,742	0.8
222C	Clarinda silty clay loam, 5 to 9 percent slopes	1,260	0.3
222C2	Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	4,444	1.4
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	5,590	1.5
269	Humeston silt loam, 0 to 2 percent slopes	940	0.3
273B	Olmitz loam, 2 to 5 percent slopes	633	0.2
273C	Olmitz loam, 5 to 9 percent slopes	699	0.2
287B	Zook-Colo-Ely silty clay loams, 2 to 5 percent slopes	11,165	3.1
315	Nodaway soils, frequently flooded, 0 to 2 percent slopes	2,021	0.6
368	Macksburg silty clay loam, 0 to 2 percent slopes	2,336	0.6
368B	Macksburg silty clay loam, 2 to 5 percent slopes	276	0.1
369	Winterset silty clay loam, 0 to 2 percent slopes	703	0.2
370	Sharpsburg silty clay loam, 0 to 2 percent slopes	1,128	0.3
370B	Sharpsburg silty clay loam, 2 to 5 percent slopes	33,683	9.2
370C	Sharpsburg silty clay loam, 5 to 9 percent slopes	19,154	5.3
370C2	Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	27,203	7.5
370D	Sharpsburg silty clay loam, 9 to 14 percent slopes	3,035	0.8
370D2	Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded	8,400	2.3
412G	Sogn soils, 25 to 40 percent slopes	104	*
428B	Ely silty clay loam, 2 to 5 percent slopes	1,255	0.3
430	Ackmore silty clay loam, 0 to 2 percent slopes	1,744	0.5
434D	Arbor loam, 9 to 14 percent slopes	438	0.1
451D2	Caleb loam, 9 to 14 percent slopes, moderately eroded	442	0.1
570B	Nira silty clay loam, 2 to 5 percent slopes	1,168	0.3
570C	Nira silty clay loam, 5 to 9 percent slopes	11,070	3.0
570C2	Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	15,026	4.1
570D2	Nira silty clay loam, 9 to 14 percent slopes, moderately eroded	1,469	0.4
675C	Dickinson-Sharpsburg complex, 5 to 9 percent slopes	272	0.1
675D2	Dickinson-Sharpsburg complex, 9 to 14 percent slopes, moderately eroded	741	0.2
792D2	Armstrong loam, 9 to 14 percent slopes, moderately eroded	1,386	0.4
822C	Lamoni silty clay loam, 5 to 9 percent slopes	481	0.1
822C2	Lamoni silty clay loam, 5 to 9 percent slopes, moderately eroded	4,111	1.1
822D	Lamoni silty clay loam, 9 to 14 percent slopes	618	0.2

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
822D2	Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	15,168	4.2
822D3	Lamoni clay, 9 to 14 percent slopes, severely eroded	451	0.1
870B	Sharpsburg silty clay loam, benches, 2 to 5 percent slopes	1,069	0.3
876B	Ladoga silt loam, benches, 2 to 5 percent slopes	726	0.2
876C	Ladoga silt loam, benches, 5 to 9 percent slopes	793	0.2
993D2	Gara-Armstrong loams, 9 to 14 percent slopes, moderately eroded	1,589	0.4
993E2	Gara-Armstrong loams, 14 to 18 percent slopes, moderately eroded	1,672	0.5
993F2	Gara-Armstrong loams, 18 to 25 percent slopes, moderately eroded	1,400	0.4
5030	Pits-Dumps complex	100	*
	Water and quarries	374	0.1
	Total	364,160	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Dashes indicate that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
8B-----Judson	124	47	93	5.2	7.3	4.2
8C-----Judson	119	45	90	5.0	7.1	4.1
11B-----Colo-Ely	108	41	80	4.3	5.9	4.2
13B-----Vesser-Nodaway	102	39	56	4.3	5.8	3.9
24C-----Shelby	93	35	51	3.9	5.3	3.7
24C2-----Shelby	90	34	50	3.8	5.3	3.5
24D-----Shelby	84	32	46	3.5	5.0	3.3
24D2-----Shelby	81	31	44	3.4	4.9	3.3
24E-----Shelby	69	26	38	2.9	4.1	2.3
24E2-----Shelby	66	25	36	2.7	4.0	2.1
24F2-----Shelby	---	---	---	---	---	1.7
51-----Vesser	95	36	52	4.0	5.0	3.7
54-----Zook	96	36	72	4.0	4.0	4.0
54+-----Zook	101	38	75	4.2	4.4	4.4
69C-----Clearfield	91	35	50	3.6	5.9	3.5
69C2-----Clearfield	88	33	48	3.5	5.8	3.5
76B-----Ladoga	113	43	62	4.7	7.8	4.3
76C-----Ladoga	108	41	59	4.5	7.5	4.0
76C2-----Ladoga	105	40	57	4.4	7.3	3.9
76D-----Ladoga	99	38	54	4.2	7.0	3.8
76D2-----Ladoga	96	36	53	4.0	6.7	3.7

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
80C----------------------- Clinton	102	39	56	4.3	6.1	3.8
80D2---------------------- Clinton	90	34	50	3.8	5.3	3.5
80E2---------------------- Clinton	75	29	41	3.2	4.6	2.5
93D2---------------------- Shelby-Adair	71	27	38	2.9	4.1	2.8
93E2---------------------- Shelby-Adair	---	---	---	2.4	3.3	1.9
133----------------------- Colo	104	40	78	4.2	5.5	4.2
133+---------------------- Colo	109	42	82	4.3	5.8	4.2
175C2--------------------- Dickinson	74	28	55	2.5	4.3	2.3
175D2--------------------- Dickinson	65	25	48	2.0	3.8	1.8
179D---------------------- Gara	78	30	43	3.3	4.7	2.7
179D2--------------------- Gara	75	28	41	3.1	4.5	2.5
179E2--------------------- Gara	---	---	---	2.2	---	1.5
179F2--------------------- Gara	---	---	---	1.2	---	1.3
192C2--------------------- Adair	65	25	36	2.7	3.5	2.3
192D2--------------------- Adair	54	20	30	2.3	2.9	1.9
212----------------------- Kennebec	121	46	80	5.1	7.1	4.2
220----------------------- Nodaway	110	42	60	4.6	6.5	4.0
222C---------------------- Clarinda	63	24	34	2.6	3.7	2.7
222C2--------------------- Clarinda	55	21	30	2.2	3.3	2.3
222D2--------------------- Clarinda	46	17	25	1.8	2.9	1.7
269----------------------- Humeston	88	33	48	3.7	5.0	3.3
273B---------------------- Olmitz	100	38	55	4.2	6.0	3.9
273C---------------------- Olmitz	95	36	52	4.0	5.7	3.7

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
287B------ Zook-Colo-Ely	105	40	79	4.3	5.3	4.1
315------ Nodaway	---	---	---	3.0	5.5	4.0
368------ Macksburg	121	46	67	5.1	8.4	4.5
368B------ Macksburg	117	44	64	4.9	8.2	4.2
369------ Winterset	117	44	64	4.9	8.2	4.3
370------ Sharpsburg	115	44	63	4.8	8.0	4.2
370B------ Sharpsburg	113	43	62	4.7	7.8	4.2
370C------ Sharpsburg	108	41	59	4.5	7.3	4.1
370C2------ Sharpsburg	108	40	58	4.4	7.0	4.0
370D------ Sharpsburg	99	38	54	4.2	6.8	3.9
370D2------ Sharpsburg	96	36	53	4.0	6.7	3.8
412G------ Sogn	---	---	---	---	---	---
428B------ Ely	124	47	93	5.3	7.5	4.0
430------ Ackmore	104	39	56	4.5	6.3	3.8
434D------ Arbor	88	33	48	3.7	5.3	3.3
451D2------ Caleb	66	25	36	2.8	4.0	2.1
570B------ Nira	114	43	63	4.8	8.0	4.5
570C------ Nira	109	41	60	4.6	7.6	4.1
570C2------ Nira	106	40	58	4.5	7.4	3.9
570D2------ Nira	97	36	53	4.1	6.8	3.5
675C------ Dickinson-Sharpsburg	92	36	59	3.7	6.0	3.4
675D2------ Dickinson-Sharpsburg	81	31	51	3.0	5.3	2.8
792D2------ Armstrong	50	19	28	2.0	2.7	1.7

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
822C: Lamoni	76	29	42	3.2	4.5	3.0
822C2: Lamoni	71	27	39	3.0	4.3	2.7
822D: Lamoni	66	25	36	2.7	4.0	2.3
822D2: Lamoni	61	23	33	2.6	3.7	2.1
822D3: Lamoni	---	---	---	1.5	---	1.9
870B: Sharpsburg	113	43	62	4.7	7.8	4.2
876B: Ladoga	113	43	62	4.7	7.8	4.3
876C: Ladoga	108	41	59	4.5	7.5	4.0
993D2: Gara-Armstrong	67	25	36	2.8	3.9	2.3
993E2: Gara-Armstrong	---	---	---	2.0	---	1.4
993F2: Gara-Armstrong	---	---	---	---	---	1.2
5030: Pits-Dumps	---	---	---	---	---	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
8B, 8C Judson	2o	Slight	Slight	Slight	Moderate	Black walnut White oak Northern red oak	73 --- ---	Black walnut, eastern cottonwood, green ash.
13B*: Vesser.								
Nodaway	3o	Slight	Slight	Slight	Moderate	White oak	65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
76B, 76C, 76C2, 76D, 76D2 Ladoga	3o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, sugar maple, white spruce.
80C, 80D2 Clinton	3o	Slight	Slight	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut.
80E2 Clinton	3r	Moderate	Moderate	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut.
175C2, 175D2 Dickinson	---	--------	--------	--------	--------	--------------------	---	Eastern white pine, red pine, jack pine.
179D, 179D2 Gara	4o	Slight	Slight	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine.
179E2, 179F2 Gara	4r	Moderate	Moderate	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine.
212 Kennebec	2o	Slight	Slight	Slight	Moderate	Black walnut Bur oak Common hackberry Green ash Eastern cottonwood	79 63 --- --- ---	Black walnut, bur oak, common hackberry, green ash, eastern cottonwood, American sycamore.

See footnote at end of table.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
220, 315*----------- Nodaway	3o	Slight	Slight	Slight	Moderate	White oak-----------	65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch. black walnut, sugar maple.
370, 370B, 370C, 370C2, 370D, 370D2------------- Sharpsburg	4o	Slight	Slight	Slight	Slight	Black oak----------- Black walnut-------- White oak----------- Common hackberry---- Green ash-----------	60 60 --- --- ---	Black walnut, common hackberry, green ash.
430---------------- Ackmore	---	--------	--------	--------	--------	-------------------	---	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, poplar.
451D2-------------- Caleb	4o	Slight	Slight	Slight	Slight	White oak----------- Northern red oak----	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
675C*, 675D2*:								
Dickinson---------	---	--------	--------	--------	--------	-------------------	---	Eastern white pine, red pine, jack pine.
Sharpsburg--------	4o	Slight	Slight	Slight	Slight	Black oak----------- Black walnut-------- White oak----------- Common hackberry---- Green ash-----------	60 60 --- --- ---	Black walnut, common hackberry, green ash.
792D2-------------- Armstrong	4c	Moderate	Moderate	Moderate	Moderate	White oak----------- Northern red oak----	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, poplar.
870B--------------- Sharpsburg	4o	Slight	Slight	Slight	Slight	Black oak----------- Black walnut-------- White oak----------- Common hackberry---- Green ash-----------	60 60 --- --- ---	Black walnut, common hackberry, green ash.

See footnote at end of table.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
876B, 876C--------- Ladoga	3o	Slight	Slight	Slight	Moderate	White oak----------- Northern red oak----	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, sugar maple, white spruce.
993D2*:								
Gara--------------	4o	Slight	Slight	Slight	Slight	White oak----------- Northern red oak----	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine.
Armstrong---------	4c	Moderate	Moderate	Moderate	Moderate	White oak----------- Northern red oak----	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, poplar.
993E2*, 993F2*:								
Gara--------------	4r	Moderate	Moderate	Slight	Slight	White oak----------- Northern red oak----	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine.
Armstrong---------	4c	Moderate	Moderate	Moderate	Moderate	White oak----------- Northern red oak----	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, poplar.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; the symbol > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
8B, 8C------------ Judson	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
11B*:					
Colo-------------	Redosier dogwood, silky dogwood.	Siberian dogwood, bloodtwig dogwood, Tatarian honeysuckle, Zabel honeysuckle.	Laurel willow, Amur maple, northern white-cedar.	Green ash---------	Silver maple, eastern cottonwood.
Ely--------------	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
13B*:					
Vesser-----------	Redosier dogwood, silky dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash---------	Eastern cottonwood, silver maple.
Nodaway----------	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
24C, 24C2, 24D, 24D2, 24E, 24E2-- Shelby	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
24F2. Shelby					
51--------------- Vesser	Redosier dogwood, silky dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash---------	Eastern cottonwood, silver maple.
54, 54+----------- Zook	Silky dogwood, redosier dogwood.	Siberian dogwood, Tatarian honeysuckle, Zabel honeysuckle, bloodtwig dogwood.	Northern white-cedar, laurel willow, Amur maple.	Green ash---------	Silver maple, eastern cottonwood.
69C, 69C2--------- Clearfield	Redosier dogwood, silky dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash---------	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
76B, 76C, 76C2, 76D, 76D2--------Ladoga	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
80C, 80D2, 80E2---Clinton	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
93D2*, 93E2*:					
Shelby-----------	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
Adair------------	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
133, 133+---------Colo	Redosier dogwood, silky dogwood.	Siberian dogwood, bloodtwig dogwood, Tatarian honeysuckle, Zabel honeysuckle.	Laurel willow, Amur maple, northern white-cedar.	Green ash---------	Silver maple, eastern cottonwood.
175C2, 175D2------Dickinson	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern cottonwood.
179D, 179D2, 179E2------------Gara	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
179F2. Gara					
192C2, 192D2------Adair	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
212---------------Kennebec	Gray dogwood, redosier dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Red pine, common hackberry, Norway spruce.	Silver maple, eastern cottonwood.
220---------------Nodaway	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
222C, 222C2, 222D2------------Clarinda	Redosier dogwood, silky dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash---------	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
269 Humeston	Redosier dogwood, silky dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash	Eastern cottonwood, silver maple.
273B, 273C Olmitz	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern cottonwood.
287B*:					
Zook	Silky dogwood, redosier dogwood.	Siberian dogwood, Tatarian honeysuckle, Zabel honeysuckle, bloodtwig dogwood.	Northern white-cedar, laurel willow, Amur maple.	Green ash	Silver maple, eastern cottonwood.
Colo	Redosier dogwood, silky dogwood.	Siberian dogwood, bloodtwig dogwood, Tatarian honeysuckle, Zabel honeysuckle.	Laurel willow, Amur maple, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
Ely	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
315* Nodaway	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
368, 368B Macksburg	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
369 Winterset	Redosier dogwood, silky dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood, Zabel honeysuckle.	Amur maple, northern white-cedar, laurel willow.	Green ash	Eastern cottonwood, silver maple.
370, 370B, 370C, 370C2, 370D, 370D2 Sharpsburg	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
412G*. Sogn					
428B Ely	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
430-----Ackmore	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
434D-----Arbor	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
451D2-----Caleb	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
570B, 570C, 570C2, 570D2-----Nira	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
675C*, 675D2*:					
Dickinson-----	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern cottonwood.
Sharpsburg-----	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
792D2-----Armstrong	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
822C, 822C2, 822D, 822D2, 822D3-----Lamoni	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
870B-----Sharpsburg	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
876B, 876C-----Ladoga	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
993D2*, 993E2*:					
Gara-----	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
Armstrong-----	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Eastern redcedar, Amur maple.	Red pine, Norway spruce, common hackberry.	Eastern cottonwood, silver maple.
993F2*:					
Gara.					
Armstrong.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
5030. Pits-Dumps					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
8B: Judson	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
8C: Judson	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: frost action, low strength.
11B*:					
Colo	Severe: wetness, floods.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, wetness.
Ely	Moderate: wetness.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: frost action, low strength.
13B*:					
Vesser	Severe: wetness, floods.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.
Nodaway	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action.
24C, 24C2: Shelby	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength, slope.	Severe: low strength.
24D, 24D2: Shelby	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
24E, 24E2, 24F2: Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
51: Vesser	Severe: wetness, floods.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.
54, 54+: Zook	Severe: wetness, floods.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, low strength, wetness.
69C, 69C2: Clearfield	Severe: wetness.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength.
76B, 76C, 76C2: Ladoga	Slight	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: frost action, low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
76D, 76D2: Ladoga	Moderate: slope.	Severe: low strength.	Severe: low strength.	Severe: slope, low strength.	Severe: frost action, low strength.
80C: Clinton	Moderate: too clayey.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: low strength.
80D2: Clinton	Moderate: too clayey, slope.	Severe: low strength.	Severe: low strength.	Severe: slope, low strength.	Severe: low strength.
80E2: Clinton	Severe: slope.	Severe: slope, low strength.	Severe: slope, low strength.	Severe: slope, low strength.	Severe: low strength, slope.
93D2*:					
Shelby	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
Adair	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action.
93E2*:					
Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Adair	Severe: wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: low strength, slope, frost action.
133, 133+: Colo	Severe: wetness, floods.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, wetness.
175C2: Dickinson	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.
175D2: Dickinson	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
179D, 179D2: Gara	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
179E2, 179F2: Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
192C2: Adair	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: low strength, frost action.
192D2: Adair	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
212-----Kennebec	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action, low strength.
220-----Nodaway	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action.
222C, 222C2, 222D2-----Clarinda	Severe: wetness.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.
269-----Humeston	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: wetness, low strength, shrink-swell.
273B-----Olmitz	Slight-----	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell.	Severe: low strength.
273C-----Olmitz	Slight-----	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, slope.	Severe: low strength.
287B*:					
Zook-----	Severe: wetness, floods.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, low strength, wetness.
Colo-----	Severe: wetness, floods.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, wetness.
Ely-----	Moderate: wetness.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: frost action, low strength.
315*-----Nodaway	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, frost action.
368, 368B-----Macksburg	Moderate: wetness, too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength, frost action.
369-----Winterset	Severe: wetness.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, frost action, low strength.
370, 370B, 370C, 370C2-----Sharpsburg	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: frost action, low strength.
370D, 370D2-----Sharpsburg	Moderate: slope, too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, slope, low strength.	Severe: frost action, low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
412G*: Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
428B: Ely	Moderate: wetness.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: frost action, low strength.
430: Ackmore	Severe: floods, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, shrink-swell.
434D: Arbor	Moderate: slope, floods.	Severe: floods.	Severe: floods.	Severe: slope, floods.	Severe: low strength.
451D2: Caleb	Moderate: slope.	Severe: low strength.	Severe: low strength.	Severe: slope, low strength.	Severe: low strength.
570B, 570C, 570C2: Nira	Slight	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: frost action, low strength.
570D2: Nira	Moderate: slope.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, slope, low strength.	Severe: frost action, low strength.
675C*:					
Dickinson	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.
Sharpsburg	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: frost action, low strength.
675D2*:					
Dickinson	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
Sharpsburg	Moderate: slope, too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, slope, low strength.	Severe: frost action, low strength.
792D2: Armstrong	Severe: wetness.	Severe: shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength, slope.	Severe: low strength, shrink-swell, frost action.
822C, 822C2: Lamoni	Severe: wetness.	Severe: shrink-swell, low strength, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.
822D, 822D2, 822D3: Lamoni	Severe: wetness.	Severe: shrink-swell, low strength, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, low strength.
870B: Sharpsburg	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: frost action, low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
876B, 876C-------- Ladoga	Slight-----------	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: frost action, low strength.
993D2*:					
Gara-------------	Moderate: slope.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.
Armstrong--------	Severe: wetness.	Severe: shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength, slope.	Severe: low strength, shrink-swell, frost action.
993E2*, 993F2*:					
Gara-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Armstrong--------	Severe: wetness, slope.	Severe: shrink-swell, low strength, slope.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength, slope.	Severe: low strength, shrink-swell, frost action.
5030. Pits-Dumps					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
8B----------------- Judson	Slight-----------	Moderate: slope, seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
8C----------------- Judson	Slight-----------	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
11B*:					
Colo---------------	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Ely----------------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
13B*:					
Vesser-------------	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Nodaway------------	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: wetness.
24C, 24C2----------- Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
24D, 24D2----------- Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
24E, 24E2, 24F2----- Shelby	Severe· percs slowly, slope.	Severe: slope.	Moderate: too clayey, slope.	Severe: slope.	Poor: slope.
51----------------- Vesser	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
54, 54+------------- Zook	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: too clayey, wetness.
69C, 69C2----------- Clearfield	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness.	Severe: wetness.	Poor: wetness.
76B----------------- Ladoga	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
76C, 76C2----------- Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
76D, 76D2----------- Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
80C----------------- Clinton	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey.
80D2---------------- Clinton	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
80E2---------------- Clinton	Severe: slope, percs slowly.	Severe: slope.	Severe: too clayey.	Severe: slope.	Poor: slope, too clayey.
93D2*:					
Shelby-------------	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
Adair--------------	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness.
93E2*:					
Shelby-------------	Severe: percs slowly, slope.	Severe: slope.	Moderate: too clayey, slope.	Severe: slope.	Poor: slope.
Adair--------------	Severe: percs slowly, slope, wetness.	Severe: slope, wetness.	Severe: wetness, too clayey.	Severe: wetness, slope.	Poor: slope, wetness.
133, 133+----------- Colo	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
175C2**------------- Dickinson	Slight-----------	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
175D2**------------- Dickinson	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
179D, 179D2--------- Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
179E2, 179F2-------- Gara	Severe: percs slowly, slope.	Severe: slope.	Moderate: too clayey, slope.	Severe: slope.	Poor: slope.
192C2, 192D2-------- Adair	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness.
212----------------- Kennebec	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
220----------------- Nodaway	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: wetness.
222C, 222C2, 222D2-- Clarinda	Severe: wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
269: Humeston	Severe: wetness, percs slowly.	Severe: floods, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness.
273B: Olmitz	Severe: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
273C: Olmitz	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
287B*:					
Zook	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: too clayey, wetness.
Colo	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Ely	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
315*: Nodaway	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: wetness.
368, 368B: Macksburg	Severe: percs slowly, wetness.	Severe: wetness.	Severe: too clayey.	Moderate: wetness.	Fair: too clayey.
369: Winterset	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness, too clayey.
370: Sharpsburg	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
370B: Sharpsburg	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
370C, 370C2: Sharpsburg	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight	Poor: too clayey.
370D, 370D2: Sharpsburg	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
412G*: Sogn	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
428B: Ely	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
430: Ackmore	Severe: percs slowly, floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
434D: Arbor	Severe: percs slowly.	Severe: slope, floods.	Moderate: too clayey, floods.	Moderate: slope, floods.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
451D2: Caleb	Severe: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness, too clayey.	Moderate: slope.	Fair: too clayey, wetness, slope.
570B: Nira	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
570C, 570C2: Nira	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
570D2: Nira	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
675C*:					
Dickinson**	Slight	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
Sharpsburg	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight	Poor: too clayey.
675D2*:					
Dickinson**	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
Sharpsburg	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
792D2: Armstrong	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
822C, 822C2, 822D, 822D2, 822D3: Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, wetness.
870B: Sharpsburg	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
876B: Ladoga	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
876C: Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
993D2*:					
Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
Armstrong	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
993E2*, 993F2*:					
Gara	Severe: percs slowly, slope.	Severe: slope.	Moderate: too clayey, slope.	Severe: slope.	Poor: slope.
Armstrong	Severe: percs slowly, slope, wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness, slope.	Poor: slope, wetness.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
5030. Pits-Dumps					

* See description of the map unit for the composition and behavior characteristics of the map unit.
** Rapid permeability can cause pollution of ground water.

TABLE 10.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definition of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
8B, 8C----------------- Judson	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
11B*:				
Colo------------------	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Ely-------------------	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
13B*:				
Vesser----------------	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Nodaway---------------	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
24C, 24C2------------- Shelby	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
24D, 24D2------------- Shelby	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
24E, 24E2, 24F2------- Shelby	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Severe: slope.
51-------------------- Vesser	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
54, 54+--------------- Zook	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
69C, 69C2------------- Clearfield	Poor: shrink-swell, low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
76B, 76C, 76C2-------- Ladoga	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
76D, 76D2------------- Ladoga	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
80C------------------- Clinton	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
80D2------------------ Clinton	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer.
80E2------------------ Clinton	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
93D2*:				
Shelby	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
Adair	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
93E2*:				
Shelby	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
Adair	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
133, 133+ Colo	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
175C2 Dickinson	Good	Fair: excess fines.	Unsuited: excess fines.	Good.
175D2 Dickinson	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: slope.
179D, 179D2 Gara	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
179E2, 179F2 Gara	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
192C2 Adair	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
192D2 Adair	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
212 Kennebec	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
220 Nodaway	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
222C, 222C2, 222D2 Clarinda	Poor: shrink-swell, wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, wetness.
269 Humeston	Poor: low strength, shrink-swell, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
273B, 273C Olmitz	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
287B*:				
Zook	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
287B*:				
Colo	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Ely	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
315* Nodaway	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
368, 368B Macksburg	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
369 Winterset	Poor: shrink-swell, wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
370, 370B, 370C, 370C2 Sharpsburg	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
370D, 370D2 Sharpsburg	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
412G* Sogn	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
428B Ely	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
430 Ackmore	Poor: low strength, shrink-swell, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
434D Arbor	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
451D2 Caleb	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, too clayey.
570B, 570C, 570C2 Nira	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
570D2 Nira	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
675C*:				
Dickinson	Good	Fair: excess fines.	Unsuited: excess fines.	Good.
Sharpsburg	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
675D2*:				
Dickinson	Good	Fair: excess fines.	Unsuited: excess fines.	Fair: slope.
Sharpsburg	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
792D2 Armstrong	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
822C, 822C2, 822D, 822D2 Lamoni	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
822D3 Lamoni	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
870B Sharpsburg	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
876B, 876C Ladoga	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
993D2*:				
Gara	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
Armstrong	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
993E2*, 993F2*:				
Gara	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
Armstrong	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
5030. Pits-Dumps				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
8B Judson	Seepage	Favorable	Not needed	Favorable	Erodes easily	Erodes easily.
8C Judson	Slope, seepage.	Favorable	Not needed	Slope	Erodes easily	Erodes easily.
11B*:						
Colo	Favorable	Hard to pack, wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.
Ely	Seepage	Favorable	Not needed	Favorable	Erodes easily	Erodes easily.
13B*:						
Vesser	Favorable	Wetness, hard to pack.	Floods, frost action.	Floods, wetness.	Wetness, erodes easily.	Erodes easily, wetness.
Nodaway	Seepage	Favorable	Not needed	Floods, erodes easily.	Not needed	Erodes easily.
24C, 24C2 Shelby	Slope	Favorable	Not needed	Slope	Favorable	Erodes easily.
24D, 24D2 Shelby	Slope	Favorable	Not needed	Slope	Favorable	Erodes easily, slope.
24E, 24E2, 24F2 Shelby	Slope	Favorable	Not needed	Slope	Slope	Erodes easily, slope.
51 Vesser	Favorable	Wetness, hard to pack.	Floods, frost action.	Floods, wetness.	Not needed	Erodes easily, wetness.
54, 54+ Zook	Favorable	Hard to pack, wetness.	Floods, percs slowly, frost action.	Floods, wetness, percs slowly.	Not needed	Favorable.
69C, 69C2 Clearfield	Slope, wetness.	Wetness, hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Wetness, erodes easily.	Wetness, erodes easily.
76B Ladoga	Favorable	Hard to pack	Not needed	Favorable	Erodes easily	Erodes easily.
76C, 76C2 Ladoga	Slope	Hard to pack	Not needed	Slope	Erodes easily	Erodes easily.
76D, 76D2 Ladoga	Slope	Hard to pack	Not needed	Slope	Erodes easily	Slope, erodes easily.
80C Clinton	Slope	Hard to pack	Not needed	Erodes easily, slope.	Favorable	Erodes easily.
80D2 Clinton	Slope	Hard to pack	Not needed	Erodes easily, slope.	Favorable	Slope, erodes easily.
80E2 Clinton	Slope	Hard to pack	Not needed	Erodes easily, slope.	Slope	Slope, erodes easily.
93D2*:						
Shelby	Slope	Favorable	Not needed	Slope	Favorable	Erodes easily, slope.
Adair	Slope	Favorable	Percs slowly, frost action.	Wetness, percs slowly, slope.	Wetness, percs slowly.	Wetness, slope, percs slowly.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
93E2*:						
Shelby	Slope	Favorable	Not needed	Slope	Slope	Erodes easily, slope.
Adair	Slope	Favorable	Percs slowly, frost action.	Wetness, percs slowly, slope.	Slope, wetness, percs slowly.	Wetness, slope, percs slowly.
133, 133+ Colo	Favorable	Hard to pack, wetness.	Floods, frost action.	Floods, wetness.	Not needed	Wetness.
175C2 Dickinson	Slope, seepage.	Seepage	Not needed	Slope, soil blowing.	Soil blowing	Droughty.
175D2 Dickinson	Slope, seepage.	Seepage	Not needed	Slope, soil blowing.	Soil blowing	Slope, droughty.
179D, 179D2 Gara	Slope	Favorable	Not needed	Slope	Favorable	Erodes easily, slope.
179E2, 179F2 Gara	Slope	Favorable	Not needed	Slope	Slope	Erodes easily, slope.
192C2 Adair	Slope	Favorable	Percs slowly, frost action.	Wetness, percs slowly, slope.	Wetness, percs slowly.	Percs slowly, wetness.
192D2 Adair	Slope	Favorable	Percs slowly, frost action.	Wetness, percs slowly, slope.	Wetness, percs slowly.	Wetness, slope, percs slowly.
212 Kennebec	Seepage	Favorable	Floods, frost action.	Floods, wetness.	Not needed	Erodes easily.
220 Nodaway	Seepage	Favorable	Not needed	Floods, erodes easily.	Not needed	Erodes easily.
222C, 222C2 Clarinda	Slope	Wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Wetness, erodes easily.
222D2 Clarinda	Slope	Wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Wetness, slope, erodes easily.
269 Humeston	Favorable	Wetness, hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Not needed	Percs slowly, wetness.
273B Olmitz	Favorable	Favorable	Not needed	Favorable	Favorable	Favorable.
273C Olmitz	Favorable	Favorable	Not needed	Slope	Favorable	Favorable.
287B*:						
Zook	Favorable	Hard to pack, wetness.	Floods, percs slowly, frost action.	Floods, wetness, percs slowly.	Not needed	Favorable.
Colo	Favorable	Hard to pack, wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.
Ely	Seepage	Favorable	Not needed	Favorable	Erodes easily	Erodes easily.
315* Nodaway	Seepage	Favorable	Not needed	Floods, erodes easily.	Not needed	Erodes easily.
368 Macksburg	Favorable	Hard to pack, wetness.	Favorable	Wetness	Not needed	Erodes easily.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
368B Macksburg	Favorable	Hard to pack, wetness.	Favorable	Wetness	Erodes easily, wetness.	Erodes easily.
369 Winterset	Favorable	Wetness, hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Not needed	Wetness, percs slowly, erodes easily.
370 Sharpsburg	Favorable	Hard to pack	Not needed	Favorable	Not needed	Erodes easily.
370B Sharpsburg	Favorable	Hard to pack	Not needed	Favorable	Erodes easily	Erodes easily.
370C, 370C2 Sharpsburg	Slope, seepage.	Hard to pack	Not needed	Slope	Erodes easily	Erodes easily.
370D, 370D2 Sharpsburg	Slope, seepage.	Hard to pack	Not needed	Slope	Erodes easily	Slope, erodes easily.
412G*: Sogn	Slope, depth to rock	Thin layer	Not needed	Droughty, rooting depth, slope.	Depth to rock, slope.	Slope, droughty, rooting depth.
428B Ely	Seepage	Favorable	Not needed	Favorable	Erodes easily	Erodes easily.
430 Ackmore	Favorable	Hard to pack	Floods, frost action.	Floods, wetness, erodes easily.	Not needed	Wetness.
434D Arbor	Slope	Favorable	Not needed	Slope	Favorable	Slope, erodes easily.
451D2 Caleb	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Slope.
570B Nira	Seepage	Hard to pack	Not needed	Favorable	Erodes easily	Erodes easily.
570C, 570C2 Nira	Slope, seepage.	Hard to pack	Not needed	Slope	Erodes easily	Erodes easily.
570D2 Nira	Slope, seepage.	Hard to pack	Not needed	Slope	Erodes easily	Slope, erodes easily.
675C*:						
Dickinson	Slope, seepage.	Seepage	Not needed	Slope, soil blowing.	Soil blowing	Droughty.
Sharpsburg	Slope, seepage.	Hard to pack	Not needed	Slope	Erodes easily	Erodes easily.
675D2*:						
Dickinson	Slope, seepage.	Seepage	Not needed	Slope, soil blowing.	Soil blowing	Slope, droughty.
Sharpsburg	Slope, seepage.	Hard to pack	Not needed	Slope	Erodes easily	Slope, erodes easily.
792D2 Armstrong	Slope	Wetness	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, slope.
822C, 822C2 Lamoni	Slope	Wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, wetness.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
822D, 822D2-------- Lamoni	Slope----------	Wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Slope, wetness, percs slowly.
822D3------------- Lamoni	Slope----------	Wetness, hard to pack.	Percs slowly, slope.	Wetness, slow intake, percs slowly.	Percs slowly, wetness.	Slope, wetness, percs slowly.
870B-------------- Sharpsburg	Favorable------	Hard to pack	Not needed-----	Favorable------	Erodes easily	Erodes easily.
876B-------------- Ladoga	Favorable------	Hard to pack	Not needed-----	Favorable------	Erodes easily	Erodes easily.
876C-------------- Ladoga	Slope----------	Hard to pack	Not needed-----	Slope----------	Erodes easily	Erodes easily.
993D2*:						
Gara--------------	Slope----------	Favorable------	Not needed-----	Slope----------	Favorable------	Erodes easily, slope.
Armstrong---------	Slope----------	Wetness--------	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, slope.
993E2*, 993F2*:						
Gara--------------	Slope----------	Favorable------	Not needed-----	Slope----------	Slope----------	Erodes easily, slope.
Armstrong---------	Slope----------	Wetness--------	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Slope, percs slowly, wetness.	Percs slowly, slope.
5030. Pits-Dumps						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
8B Judson	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
8C Judson	Moderate: too clayey.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
11B*:				
Colo	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Ely	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
13B*:				
Vesser	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Nodaway	Severe: floods.	Slight	Moderate: floods.	Slight.
24C, 24C2 Shelby	Moderate: percs slowly.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
24D, 24D2 Shelby	Moderate: slope, percs slowly.	Moderate: too clayey, slope.	Severe: slope.	Moderate: too clayey.
24E, 24E2, 24F2 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too clayey, slope.
51 Vesser	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
54, 54+ Zook	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
69C, 69C2 Clearfield	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.
76B Ladoga	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
76C, 76C2 Ladoga	Moderate: percs slowly.	Slight	Severe: slope.	Slight.
76D, 76D2 Ladoga	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
80C Clinton	Moderate: percs slowly.	Slight	Severe: slope.	Slight.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
80D2: Clinton	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight.
80E2: Clinton	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
93D2*:				
Shelby	Moderate: slope, percs slowly.	Moderate: too clayey, slope.	Severe: slope.	Moderate: too clayey.
Adair	Moderate: slope, wetness, percs slowly.	Moderate: wetness, slope.	Severe: slope.	Moderate: wetness, too clayey.
93E2*:				
Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: too clayey, slope.
Adair	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: wetness, too clayey, slope.
133, 133+: Colo	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.
175C2: Dickinson	Slight	Slight	Severe: slope.	Slight.
175D2: Dickinson	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
179D, 179D2: Gara	Moderate: percs slowly, slope.	Moderate: slope.	Severe: slope.	Slight.
179E2, 179F2: Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
192C2: Adair	Moderate: wetness, percs slowly.	Moderate: wetness.	Severe: slope.	Moderate: wetness, too clayey.
192D2: Adair	Moderate: slope, wetness, percs slowly.	Moderate: wetness, slope.	Severe: slope.	Moderate: wetness, too clayey.
212: Kennebec	Severe: floods.	Slight	Moderate: floods.	Slight.
220: Nodaway	Severe: floods.	Slight	Moderate: floods.	Slight.
222C, 222C2, 222D2: Clarinda	Severe: percs slowly, wetness.	Severe: wetness.	Severe: slope, wetness, percs slowly.	Severe: wetness.
269: Humeston	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
273B Olmitz	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
273C Olmitz	Moderate: percs slowly.	Slight	Severe: slope.	Slight.
287B*:				
Zook	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Colo	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Ely	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
315* Nodaway	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
368 Macksburg	Moderate: wetness, percs slowly, too clayey.	Moderate: wetness, too clayey.	Moderate: too clayey, wetness.	Moderate: too clayey.
368B Macksburg	Moderate: wetness, percs slowly, too clayey.	Moderate: wetness, too clayey.	Moderate: slope, too clayey, wetness.	Moderate: too clayey.
369 Winterset	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
370 Sharpsburg	Moderate: percs slowly.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
370B Sharpsburg	Moderate: percs slowly.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
370C, 370C2 Sharpsburg	Moderate: percs slowly.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
370D, 370D2 Sharpsburg	Moderate: slope, percs slowly.	Moderate: slope, too clayey.	Severe: slope.	Moderate: too clayey.
412G* Sogn	Severe: depth to rock.	Severe: slope.	Severe: depth to rock, slope.	Slight.
428B Ely	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
430 Ackmore	Severe: floods, wetness.	Moderate: wetness, floods, too clayey.	Severe: wetness, floods.	Moderate: wetness, too clayey, floods.
434D Arbor	Severe: floods.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
451D2 Caleb	Moderate: percs slowly, slope.	Moderate: slope.	Severe: slope.	Slight.
570B Nira	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: slope, too clayey, percs slowly.	Moderate: too clayey.
570C, 570C2 Nira	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
570D2 Nira	Moderate: percs slowly, too clayey, slope.	Moderate: too clayey, slope.	Severe: slope.	Moderate: too clayey.
675C*:				
Dickinson	Slight	Slight	Severe: slope.	Slight.
Sharpsburg	Moderate: percs slowly.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.
675D2*:				
Dickinson	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Sharpsburg	Moderate: slope, percs slowly.	Moderate: slope, too clayey.	Severe: slope.	Moderate: too clayey.
792D2 Armstrong	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness.	Severe: slope.	Slight.
822C, 822C2 Lamoni	Severe: wetness, percs slowly.	Moderate: wetness.	Severe: slope, wetness.	Moderate: wetness, too clayey.
822D, 822D2 Lamoni	Severe: wetness, percs slowly.	Moderate: slope, wetness.	Severe: slope, wetness.	Moderate: wetness, too clayey.
822D3 Lamoni	Severe: wetness, percs slowly.	Severe: too clayey.	Severe: slope, too clayey, wetness.	Severe: too clayey.
870B Sharpsburg	Moderate: percs slowly.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
876B Ladoga	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
876C Ladoga	Moderate: percs slowly.	Slight	Severe: slope.	Slight.
993D2*:				
Gara	Moderate: percs slowly, slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
993D2*:				
Armstrong	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness.	Severe: slope.	Slight.
993E2*, 993F2*:				
Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Armstrong	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
5030. Pits-Dumps				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definition of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
8B Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
8C Judson	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
11B*:										
Colo	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
13B*:										
Vesser	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
24C, 24C2, 24D, 24D2 Shelby	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
24E, 24E2, 24F2 Shelby	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
51 Vesser	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
54, 54+ Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
69C, 69C2 Clearfield	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
76B Ladoga	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
76C, 76C2, 76D, 76D2 Ladoga	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
80C, 80D2 Clinton	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
80E2 Clinton	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
93D2*:										
Shelby	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
93E2*:										
Shelby	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
133, 133+ Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
175C2, 175D2 Dickinson	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
179D, 179D2: Gara	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Poor.
179E2, 179F2: Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
192C2, 192D2: Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
212: Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
220: Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
222C, 222C2, 222D2: Clarinda	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
269: Humeston	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
273B: Olmitz	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
273C: Olmitz	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
287B*:										
Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Colo	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
315*: Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
368, 368B: Macksburg	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
369: Winterset	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
370, 370B: Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
370C, 370C2, 370D, 370D2: Sharpsburg	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
412G*: Sogn	Very poor.	Very poor.	Poor	---	---	Very poor.	Very poor.	Very poor.	---	Very poor.
428B: Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
430: Ackmore	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
434D: Arbor	Poor	Fair	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
451D2: Caleb	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Good	Poor.

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
570B-----------Nira	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
570C, 570C2, 570D2-Nira	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
675C*, 675D2*:										
Dickinson----------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Sharpsburg--------	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
792D2-----------Armstrong	Fair	Good	Fair	Good	Fair	Very poor.	Poor	Fair	Good	Very poor.
822C, 822C2, 822D, 822D2, 822D3------Lamoni	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
870B-----------Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
876B-----------Ladoga	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
876C-----------Ladoga	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
993D2*:										
Gara--------------	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Poor.
Armstrong---------	Fair	Good	Fair	Good	Fair	Very poor.	Poor	Fair	Good	Very poor.
993E2*, 993F2*:										
Gara--------------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Armstrong---------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
5030. Pits-Dumps										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
8B, 8C------------- Judson	0-21	Silty clay loam	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	21-72	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
11B*:											
Colo--------------	0-27	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	27-54	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	54-78	Silty clay loam, clay loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Ely---------------	0-22	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	10-25
	22-66	Silty clay loam	CL	A-7, A-6	0	100	100	95-100	95-100	35-50	10-25
13B*:											
Vesser------------	0-15	Silt loam-------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	15-33	Silt loam-------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	33-65	Silty clay loam	CL, CH	A-7	0	100	100	98-100	95-100	40-55	20-30
Nodaway-----------	0-78	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
24C, 24C2, 24D, 24D2, 24E, 24E2, 24F2------------- Shelby	0-11	Clay loam-------	CL	A-6	0	90-100	85-98	75-90	55-70	30-40	11-20
	11-48	Clay loam-------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	30-45	15-25
	48-72	Clay loam-------	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	30-45	15-25
51---------------- Vesser	0-15	Silt loam-------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	15-33	Silt loam-------	CL	A-6	0	100	100	98-100	95-100	30-40	10-20
	33-65	Silty clay loam	CL, CH	A-7	0	100	100	98-100	95-100	40-55	20-30
54---------------- Zook	0-23	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	23-64	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
54+--------------- Zook	0-23	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	23-64	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
69C, 69C2---------- Clearfield	0-14	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-55	20-30
	14-40	Silty clay loam	CH	A-7	0	100	100	100	95-100	50-60	25-35
	40-76	Silty clay, silty clay loam, clay.	CH	A-7	0	100	100	95-100	80-90	55-70	35-45
76B, 76C, 76C2, 76D, 76D2--------- Ladoga	0-10	Silt loam-------	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	10-50	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	41-55	25-35
	50-90	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20
80C, 80D2, 80E2---- Clinton	0-12	Silt loam-------	ML	A-4	0	100	100	100	95-100	30-40	5-10
	12-44	Silty clay, silty clay loam.	CL, CH	A-7	0	100	100	100	95-100	40-55	25-35
	44-96	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
93D2*, 93E2*:											
Shelby	0-11	Clay loam	CL	A-6	0	90-100	85-98	75-90	55-70	30-40	11-20
	11-48	Clay loam	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	30-45	15-25
	48-72	Clay loam	CL	A-6, A-7	0	90-100	85-98	75-90	55-70	30-45	15-25
Adair	0-15	Clay loam	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	11-20
	15-26	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	41-55	20-30
	26-72	Clay loam	CL	A-6, A-7	0	95-100	80-95	70-90	55-80	35-45	15-25
133 Colo	0-27	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	27-54	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	54-78	Silty clay loam, clay loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
133+ Colo	0-15	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	15-54	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	54-78	Silty clay loam, clay loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
175C2, 175D2 Dickinson	0-26	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	26-37	Fine sandy loam, sandy loam, loamy fine sand.	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	20-50	10-30	NP-10
	37-67	Loamy sand, loamy fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
179D, 179D2, 179E2, 179F2 Gara	0-10	Loam	CL, CL-ML	A-4, A-6	0	85-95	80-90	70-80	55-70	20-30	5-15
	10-48	Clay loam	CL	A-6	0	85-95	80-90	70-85	55-75	30-40	15-25
	48-74	Loam, clay loam	CL	A-6, A-7	0	85-95	80-90	70-85	55-75	35-45	15-25
192C2, 192D2 Adair	0-15	Clay loam	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	11-20
	15-26	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	41-55	20-30
	26-72	Clay loam	CL	A-6, A-7	0	95-100	80-95	70-90	55-80	35-45	15-25
212 Kennebec	0-37	Silt loam	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	37-60	Silt loam, silty clay loam.	CL, CL-ML	A-6	0	100	100	95-100	90-100	25-40	5-15
220 Nodaway	0-78	Silt loam	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
222C, 222C2, 222D2 Clarinda	0-13	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-100	40-50	20-30
	13-40	Silty clay, clay	CH	A-7	0	100	95-100	85-100	80-100	55-70	30-40
	40-73	Clay	CH	A-7	0	95-100	95-100	80-95	75-90	50-60	25-35
269 Humeston	0-16	Silt loam	CL, CL-ML	A-6, A-4	0	100	100	95-100	95-100	25-40	5-20
	16-29	Silt loam	CL, CL-ML	A-7, A-6, A-4	0	100	100	95-100	95-100	25-45	5-20
	29-67	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	95-100	45-55	25-35
273B, 273C Olmitz	0-17	Loam	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
	17-72	Clay loam	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
287B*:											
Zook	0-23	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
Colo	0-27	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	27-54	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	54-78	Silty clay loam, clay loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
287B*:											
Ely	0-22	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	10-25
	22-66	Silty clay loam	CL	A-7, A-6	0	100	100	95-100	95-100	35-50	10-25
315* Nodaway	0-78	Silt loam	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
368, 368B Macksburg	0-20	Silty clay loam	ML, OL, MH, OH	A-7	0	100	100	100	95-100	41-55	15-25
	20-43	Silty clay loam, silty clay.	CH	A-7	0	100	100	100	95-100	50-60	25-35
	43-77	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	41-55	25-35
369 Winterset	0-16	Silty clay loam	CL	A-7	0	100	100	100	95-100	40-50	20-30
	16-40	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	50-70	30-40
	40-72	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	45-55	25-35
370, 370B, 370C, 370C2, 370D, 370D2 Sharpsburg	0-21	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	21-50	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-60	20-35
	50-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
412G* Sogn	0-9	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	9-16	Fragmental silty clay loam	GW-GC, GW	A-1, A-2	60-95	15-40	15-40	15-30	10-20	20-30	5-15
	16-24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
428B Ely	0-22	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	10-25
	22-66	Silty clay loam	CL	A-7, A-6	0	100	100	95-100	95-100	35-50	10-25
430 Ackmore	0-25	Silty clay loam	CL, ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	8-20
	25-62	Silty clay loam, silt loam.	CH, CL, MH, ML	A-7, A-6	0	100	100	95-100	85-100	35-65	15-30
434D Arbor	0-18	Loam	CL	A-6	0	95-100	95-100	85-95	60-75	30-40	11-20
	18-60	Clay loam	CL	A-6, A-7	0	95-100	90-100	85-95	55-75	35-45	15-25
451D2 Caleb	0-6	Loam	CL	A-6	0	90-100	80-100	70-90	60-80	30-40	10-20
	6-28	Clay loam, loam, sandy clay loam.	CL, CH	A-6, A-7	0	85-100	80-100	60-80	50-75	35-55	15-30
	28-67	Sandy clay loam, sandy loam.	SC, CL, SM-SC, CL-ML	A-4, A-6	0	85-100	80-100	50-75	35-60	20-35	5-15
570B, 570C, 570C2, 570D2 Nira	0-10	Silty clay loam	CL, OL, CH, OH	A-7	0	100	100	100	95-100	40-55	15-25
	10-42	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	20-30
	42-92	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-45	15-25

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
675C*, 675D2*:											
Dickinson----------	0-26	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	26-37	Fine sandy loam, sandy loam, loamy fine sand.	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	20-50	10-30	NP-10
	37-67	Loamy sand, loamy fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
Sharpsburg---------	0-21	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	21-50	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-60	20-35
	50-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
792D2-------------- Armstrong	0-12	Loam------------	CL, CL-ML	A-6, A-4	0	95-100	80-95	75-90	55-80	20-40	5-20
	12-41	Clay loam, clay, silty clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	45-60	20-30
	41-72	Clay loam--------	CL	A-6	0	95-100	80-95	70-90	55-80	30-40	15-20
822C, 822C2, 822D, 822D2------------- Lamoni	0-10	Silty clay loam	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	10-40	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	40-96	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
822D3-------------- Lamoni	0-8	Clay------------	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	8-40	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	40-96	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
870B--------------- Sharpsburg	0-21	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	21-50	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-60	20-35
	50-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
876B, 876C--------- Ladoga	0-10	Silt loam--------	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	10-50	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	41-55	25-35
	50-90	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20
993D2*, 993E2*, 993F2*:											
Gara--------------	0-10	Loam------------	CL, CL-ML	A-4, A-6	0	85-95	80-90	70-80	55-70	20-30	5-15
	10-48	Clay loam--------	CL	A-6	0	85-95	80-90	70-85	55-75	30-40	15-25
	48-74	Loam, clay loam	CL	A-6, A-7	0	85-95	80-90	70-85	55-75	35-45	15-25
Armstrong---------	0-12	Loam------------	CL, CL-ML	A-6, A-4	0	95-100	80-95	75-90	55-80	20-40	5-20
	12-41	Clay loam, clay, silty clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	45-60	20-30
	41-72	Clay loam--------	CL	A-6	0	95-100	80-95	70-90	55-80	30-40	15-20
5030. Pits-Dumps											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion Factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
8B, 8C----------- Judson	0-21	0.6-2.0	0.21-0.23	6.1-7.3	Moderate------	0.28	5	7
	21-72	0.6-2.0	0.21-0.23	6.1-7.8	Moderate------	0.43		
11B*:								
Colo------------	0-27	0.2-0.6	0.21-0.23	5.6-7.3	High----------	0.28	5	7
	27-54	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.28		
	54-78	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.28		
Ely-------------	0-22	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.32	5	7
	22-66	0.6-2.0	0.18-0.20	6.1-7.3	Moderate------	0.43		
13B*:								
Vesser----------	0-15	0.6-2.0	0.20-0.24	5.6-7.3	Moderate------	0.32	5	7
	15-33	0.6-2.0	0.18-0.22	5.1-6.0	Moderate------	0.43		
	33-65	0.2-0.6	0.17-0.21	5.6-6.5	Moderate------	0.43		
Nodaway---------	0-78	0.6-2.0	0.20-0.23	6.1-7.3	Moderate------	0.37	5	7
24C, 24C2, 24D, 24D2, 24E, 24E2, 24F2------------ Shelby	0-11	0.6-2.0	0.20-0.22	5.6-6.5	Moderate------	0.28	5-4	6
	11-48	0.2-0.6	0.16-0.18	5.6-7.8	Moderate------	0.28		
	48-72	0.2-0.6	0.16-0.18	6.6-8.4	Moderate------	0.37		
51-------------- Vesser	0-15	0.6-2.0	0.20-0.24	5.6-7.3	Moderate------	0.32	5	7
	15-33	0.6-2.0	0.18-0.22	5.1-6.0	Moderate------	0.43		
	33-65	0.2-0.6	0.17-0.21	5.6-6.5	Moderate------	0.43		
54-------------- Zook	0-23	0.2-0.6	0.21-0.23	5.6-7.8	High----------	0.28	5	7
	23-64	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.28		
54+------------- Zook	0-23	0.6-2.0	0.22-0.24	5.6-7.8	Moderate------	0.28	5	6
	23-64	0.06-0.2	0.11-0.13	5.6-7.8	High----------	0.28		
69C, 69C2-------- Clearfield	0-14	0.2-0.6	0.21-0.23	5.6-7.3	High----------	0.28	5	7
	14-40	0.2-0.6	0.18-0.20	5.6-7.3	High----------	0.43		
	40-76	<0.06	0.10-0.12	5.6-7.3	High----------	0.43		
76B, 76C, 76C2, 76D, 76D2------- Ladoga	0-10	0.6-2.0	0.22-0.24	6.1-6.5	Low-----------	0.32	5	6
	10-50	0.2-0.6	0.18-0.20	5.1-6.0	Moderate------	0.43		
	50-90	0.2-0.6	0.18-0.20	5.1-6.5	Moderate------	0.43		
80C, 80D2, 80E2-- Clinton	0-12	0.6-2.0	0.20-0.22	5.6-6.5	Low-----------	0.37	5	6
	12-44	0.2-0.6	0.16-0.20	5.1-6.0	Moderate------	0.37		
	44-96	0.6-2.0	0.18-0.20	6.1-6.5	Moderate------	0.37		
93D2*, 93E2*:								
Shelby----------	0-11	0.6-2.0	0.20-0.22	5.6-6.5	Moderate------	0.28	5-4	6
	11-48	0.2-0.6	0.16-0.18	5.6-7.8	Moderate------	0.28		
	48-72	0.2-0.6	0.16-0.18	6.6-8.4	Moderate------	0.37		
Adair-----------	0-15	0.2-0.6	0.17-0.19	5.6-6.5	Moderate------	0.32	2	6
	15-26	0.06-0.2	0.13-0.16	5.1-6.5	High----------	0.32		
	26-72	0.2-0.6	0.14-0.16	5.6-6.5	Moderate------	0.32		
133------------- Colo	0-27	0.2-0.6	0.21-0.23	5.6-7.3	High----------	0.28	5	7
	27-54	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.28		
	54-78	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.28		
133+------------ Colo	0-15	0.6-2.0	0.22-0.24	6.6-7.3	Moderate------	0.28	5	6
	15-54	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.28		
	54-78	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
175C2, 175D2----- Dickinson	0-26	2.0-6.0	0.12-0.15	5.6-6.5	Low-----------	0.20	4-3	3
	26-37	2.0-20	0.08-0.15	5.6-6.5	Low-----------	0.20		
	37-67	6.0-20	0.08-0.10	5.6-6.5	Low-----------	0.20		
179D, 179D2, 179E2, 179F2---- Gara	0-10	0.6-2.0	0.20-0.22	5.6-6.0	Moderate------	0.28	5	6
	10-48	0.2-0.6	0.16-0.18	5.1-6.5	Moderate------	0.28		
	48-74	0.2-0.6	0.16-0.18	6.6-7.8	Moderate------	0.37		
192C2, 192D2----- Adair	0-15	0.2-0.6	0.17-0.19	5.6-6.5	Moderate------	0.32	2	6
	15-26	0.06-0.2	0.13-0.16	5.1-6.5	High----------	0.32		
	26-72	0.2-0.6	0.14-0.16	5.6-6.5	Moderate------	0.32		
212-------------- Kennebec	0-37	0.6-2.0	0.22-0.24	5.6-7.3	Moderate------	0.32	5	6
	37-60	0.6-2.0	0.20-0.22	6.1-7.3	Moderate------	0.43		
220-------------- Nodaway	0-78	0.6-2.0	0.20-0.23	6.1-7.3	Moderate------	0.37	5	7
222C, 222C2, 222D2----------- Clarinda	0-13	0.2-0.6	0.17-0.19	5.1-6.5	Moderate------	0.37	3	7
	13-40	<0.06	0.14-0.16	5.1-6.5	High----------	0.37		
	40-73	<0.06	0.14-0.16	5.6-7.3	High----------	0.37		
269-------------- Humeston	0-16	0.2-2.0	0.21-0.23	5.1-6.0	Moderate------	0.32	4	7
	16-29	0.2-2.0	0.20-0.22	4.5-6.0	Moderate------	0.32		
	29-67	<0.06	0.13-0.15	4.5-6.5	High----------	0.32		
273B, 273C------- Olmitz	0-17	0.6-2.0	0.19-0.21	5.6-6.5	Moderate------	0.28	5	6
	17-72	0.2-2.0	0.15-0.17	5.1-6.5	Moderate------	0.28		
287B*:								
Zook------------	0-23	0.2-0.6	0.21-0.23	5.6-7.8	High----------	0.28	5	7
Colo------------	0-27	0.2-0.6	0.21-0.23	5.6-7.3	High----------	0.28	5	7
	27-54	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.28		
	54-78	0.2-0.6	0.18-0.20	6.1-7.3	High----------	0.28		
Ely-------------	0-22	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.32	5	7
	22-66	0.6-2.0	0.18-0.20	6.1-7.3	Moderate------	0.43		
315*------------- Nodaway	0-78	0.6-2.0	0.20-0.23	6.1-7.3	Moderate------	0.37	5	7
368, 368B-------- Macksburg	0-20	0.6-2.0	0.21-0.23	5.1-6.5	Moderate------	0.32	5	6
	20-43	0.2-0.6	0.18-0.20	5.1-6.0	High----------	0.43		
	43-77	0.2-0.6	0.18-0.20	5.6-6.5	High----------	0.43		
369-------------- Winterset	0-16	0.2-0.6	0.21-0.23	5.6-7.3	Moderate------	---	---	7
	16-40	0.06-0.6	0.14-0.18	5.6-6.5	High----------	---		
	40-72	0.2-0.6	0.18-0.20	6.1-7.3	High----------	---		
370, 370B, 370C, 370C2, 370D, 370D2----------- Sharpsburg	0-21	0.6-2.0	0.21-0.23	5.1-6.5	Moderate------	0.32	5	7
	21-50	0.2-0.6	0.18-0.20	5.1-6.0	High----------	0.43		
	50-60	0.2-0.6	0.18-0.20	6.1-6.5	Moderate------	0.43		
412G*------------ Sogn	0-9	0.6-2.0	0.17-0.22	6.1-8.4	Moderate------	0.28	1	4L
	9-16	>20	0.02-0.04	6.6-8.4	Low-----------	---	---	---
	16-24	---	---	---	--------------	---		
428B------------- Ely	0-22	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.32	5	7
	22-66	0.6-2.0	0.18-0.20	6.1-7.3	Moderate------	0.43		
430-------------- Ackmore	0-25	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.37	5	6
	25-62	0.2-2.0	0.18-0.20	5.6-7.8	High----------	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
434D-------------	0-18	0.6-2.0	0.19-0.21	5.6-6.5	Moderate------	0.28	5	6
Arbor	18-60	0.2-0.6	0.15-0.17	5.1-7.3	Moderate------	0.28		
451D2------------	0-6	0.6-2.0	0.14-0.18	4.5-6.0	Low-----------	0.28	5-4	6
Caleb	6-28	0.2-0.6	0.14-0.18	4.5-6.0	Moderate------	0.28		
	28-67	0.6-2.0	0.12-0.16	6.1-6.5	Low-----------	0.28		
570B, 570C, 570C2, 570D2----	0-10	0.6-2.0	0.21-0.23	5.6-6.5	Moderate------	0.32	5	7
Nira	10-42	0.2-0.6	0.18-0.20	5.6-6.0	High----------	0.43		
	42-92	0.6-2.0	0.18-0.20	5.6-6.5	Moderate------	0.43		
675C*, 675D2*:								
Dickinson-------	0-26	2.0-6.0	0.12-0.15	5.6-6.5	Low-----------	0.20	4-3	3
	26-37	2.0-20	0.12-0.15	5.6-6.5	Low-----------	0.20		
	37-67	6.0-20	0.08-0.10	5.6-6.5	Low-----------	0.20		
Sharpsburg------	0-21	0.6-2.0	0.21-0.23	5.1-6.5	Moderate------	0.32	5	7
	21-50	0.2-0.6	0.18-0.20	5.1-6.0	High----------	0.43		
	50-60	0.2-0.6	0.18-0.20	6.1-6.5	Moderate------	0.43		
792D2------------	0-12	0.6-2.0	0.20-0.22	5.6-6.5	Moderate------	0.32	3-2	6
Armstrong	12-41	0.06-0.2	0.11-0.16	5.1-6.5	High----------	0.32		
	41-72	0.2-0.6	0.14-0.16	5.1-6.5	Moderate------	0.32		
822C, 822C2, 822D, 822D2-----	0-10	0.2-0.6	0.17-0.21	5.1-6.5	Moderate------	0.32	2	7
Lamoni	10-40	<0.2	0.13-0.17	5.1-6.5	High----------	0.32		
	40-96	0.06-0.2	0.14-0.18	6.1-6.5	High----------	0.32		
822D3------------	0-8	<0.2	0.13-0.17	5.1-6.5	High----------	0.32	2	4
Lamoni	8-40	<0.2	0.13-0.17	5.1-6.5	High----------	0.32		
	40-96	0.06-0.2	0.14-0.18	6.1-6.5	High----------	0.32		
870B-------------	0-21	0.6-2.0	0.21-0.23	5.1-6.5	Moderate------	0.32	5	7
Sharpsburg	21-50	0.2-0.6	0.18-0.20	5.1-6.0	High----------	0.43		
	50-60	0.2-0.6	0.18-0.20	6.1-6.5	Moderate------	0.43		
876B, 876C-------	0-10	0.6-2.0	0.22-0.24	6.1-6.5	Low-----------	0.32	5	6
Ladoga	10-50	0.2-0.6	0.18-0.20	5.1-6.0	Moderate------	0.43		
	50-90	0.2-0.6	0.18-0.20	5.1-6.5	Moderate------	0.43		
993D2*, 993E2*, 993F2*:								
Gara-----------	0-10	0.6-2.0	0.20-0.22	5.6-6.0	Moderate------	0.28	5	6
	10-48	0.2-0.6	0.16-0.18	5.1-6.5	Moderate------	0.28		
	48-74	0.2-0.6	0.16-0.18	6.6-7.8	Moderate------	0.37		
Armstrong------	0-12	0.6-2.0	0.20-0.22	5.6-6.5	Moderate------	0.32	3-2	6
	12-41	0.06-0.2	0.11-0.16	5.1-6.5	High----------	0.32		
	41-72	0.2-0.6	0.14-0.16	5.1-6.5	Moderate------	0.32		
5030. Pits-Dumps								

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definition of "flooding" and of "water table" in the Glossary explains terms such as "rare," "brief," "apparent," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that the soil was not evaluated]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
8B, 8C----------- Judson	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Low.
11B*:												
Colo------------	B/D	Common------	Very brief to long.	Feb-Nov	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
Ely-------------	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
13B*:												
Vesser----------	C	Common------	Brief to long.	Feb-Nov	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
Nodaway---------	B	Common------	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
24C, 24C2, 24D, 24D2, 24E, 24E2, 24F2------------ Shelby	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
51--------------- Vesser	C	Common------	Brief to long.	Feb-Nov	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
54, 54+---------- Zook	C/D	Common------	Brief-----	Feb-Nov	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
69C, 69C2--------- Clearfield	C	None--------	---	---	0-1.0	Perched	Apr-Jul	>60	---	High-----	High-----	Low.
76B, 76C, 76C2, 76D, 76D2-------- Ladoga	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
80C, 80D2, 80E2--- Clinton	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
93D2*, 93E2*:												
Shelby----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Adair-----------	D	None--------	---	---	1.0-3.0	Perched	Nov-Mar	>60	---	High-----	High-----	Moderate.
133, 133+-------- Colo	B/D	Common------	Very brief to long.	Feb-Nov	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
175C2, 175D2------ Dickinson	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
179D, 179D2, 179E2, 179F2----- Gara	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
192C2, 192D2------ Adair	D	None---------	---	---	1.0-3.0	Perched	Nov-Mar	>60	---	High-----	High-----	Moderate.
212--------------- Kennebec	B	Common------	Brief-----	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
220--------------- Nodaway	B	Common------	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
222C, 222C2, 222D2------------ Clarinda	D	None---------	---	---	0-1.0	Perched	Nov-May	>60	---	Moderate	High-----	Moderate.
269--------------- Humeston	C	Rare---------	---	---	0-1.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
273B, 273C-------- Olmitz	B	None to rare	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
287B*:												
Zook--------------	C/D	Common------	Brief-----	Feb-Nov	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
Colo--------------	B/D	Common------	Very brief to long.	Feb-Nov	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
Ely---------------	B	None---------	---	---	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
315*-------------- Nodaway	B	Common------	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
368, 368B--------- Macksburg	B	None---------	---	---	2.0-3.0	Perched	Apr-Jul	>60	---	High-----	High-----	Moderate.
369--------------- Winterset	C	None---------	---	---	0-1.0	Perched	Apr-Jul	>60	---	High-----	High-----	Moderate.
370, 370B, 370C, 370C2, 370D, 370D2----------- Sharpsburg	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
412G*------------- Sogn	D	None---------	---	---	>6.0	---	---	4-20	Hard	Moderate	Low------	Low.
428B-------------- Ely	B	None---------	---	---	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
430--------------- Ackmore	B	Common------	Very brief to brief.	Sep-Jun	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
434D-------------- Arbor	B	Rare--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
451D2------------- Caleb	B	None--------	---	---	3.0-5.0	Perched	Nov-Mar	>60	---	Moderate	Moderate	Moderate.
570B, 570C, 570C2, 570D2------------ Nira	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
675C*, 675D2*:												
Dickinson--------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
Sharpsburg-------	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
792D2------------- Armstrong	D	None--------	---	---	1.5-3.0	Perched	Nov-Mar	>60	---	High-----	High-----	Moderate.
822C, 822C2, 822D, 822D2, 822D3----- Lamoni	D	None--------	---	---	1.0-3.0	Perched	Nov-May	>60	---	Moderate	High-----	Moderate.
870B-------------- Sharpsburg	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
876B, 876C-------- Ladoga	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
993D2*, 993E2*, 993F2*:												
Gara-------------	C	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Armstrong--------	D	None--------	---	---	1.5-3.0	Perched	Nov-Mar	>60	---	High-----	High-----	Moderate.
5030. Pits-Dumps												

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
*Ackmore	Fine-silty, mixed, nonacid, mesic Aeric Fluvaquents
*Adair	Fine, montmorillonitic, mesic Aquic Argiudolls
Arbor	Fine-loamy, mixed, mesic Typic Hapludolls
*Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
*Caleb	Fine-loamy, mixed, mesic Mollic Hapludalfs
*Clarinda	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Clearfield	Fine, montmorillonitic, mesic, sloping Typic Haplaquolls
Clinton	Fine, montmorillonitic, mesic Typic Hapludalfs
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
*Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Ely	Fine-silty, mixed, mesic Cumulic Hapludolls
*Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Humeston	Fine, montmorillonitic, mesic Argiaquic Argialbolls
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
*Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
*Ladoga	Fine, montmorillonitic, mesic Mollic Hapludalfs
*Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Macksburg	Fine, montmorillonitic, mesic Aquic Argiudolls
Nira	Fine-silty, mixed, mesic Typic Hapludolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Vesser	Fine-silty, mixed, mesic Argiaquic Argialbolls
Winterset	Fine, montmorillonitic, mesic Typic Argiaquolls
*Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

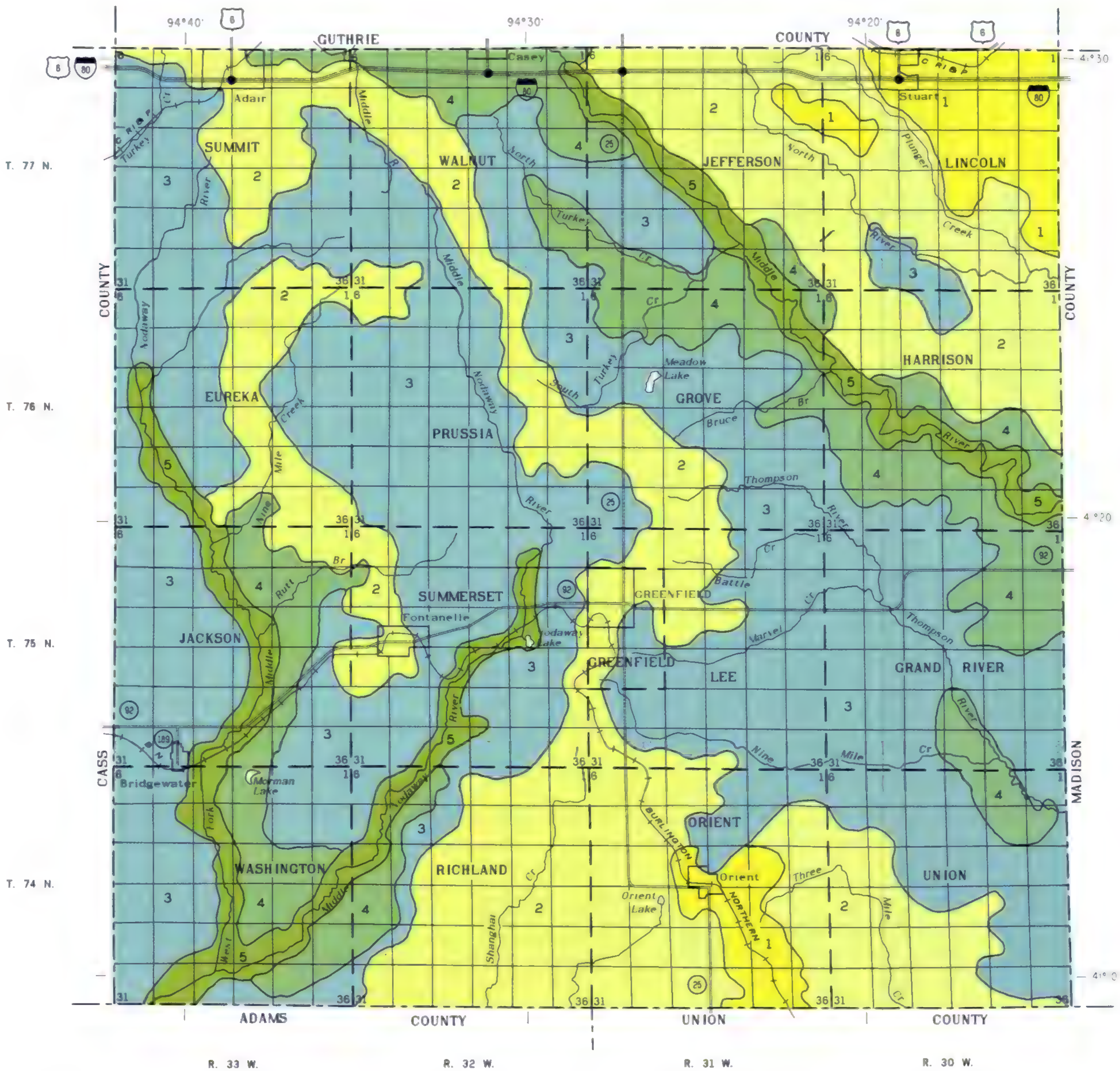
* U. S. GOVERNMENT PRINTING OFFICE : 1980 O - 295-050

NRCS Accessibility Statement

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

GENERAL SOIL MAP
ADAIR COUNTY, IOWA

Scale 1:190,080



SOIL LEGEND

1	Macksburg-Sharpsburg-Winterset: Nearly level to moderately sloping, moderately well drained to poorly drained silty clay loam soils that formed in loess; on uplands
2	Sharpsburg-Nira: Nearly level to moderately sloping, moderately well drained silty clay loam soils that formed in loess; on uplands
3	Sharpsburg-Shelby: Moderately sloping to steep, moderately well drained silty clay loam and clay loam soils that formed in loess and glacial till; on uplands
4	Gara-Ladoga: Gently sloping to steep, moderately well drained and well drained loam and silt loam soils that formed in glacial till and loess; on uplands
5	Colo-Zook-Nodaway: Nearly level, moderately well drained and poorly drained silty clay loam and silt loam soils that formed in alluvium; on bottom lands

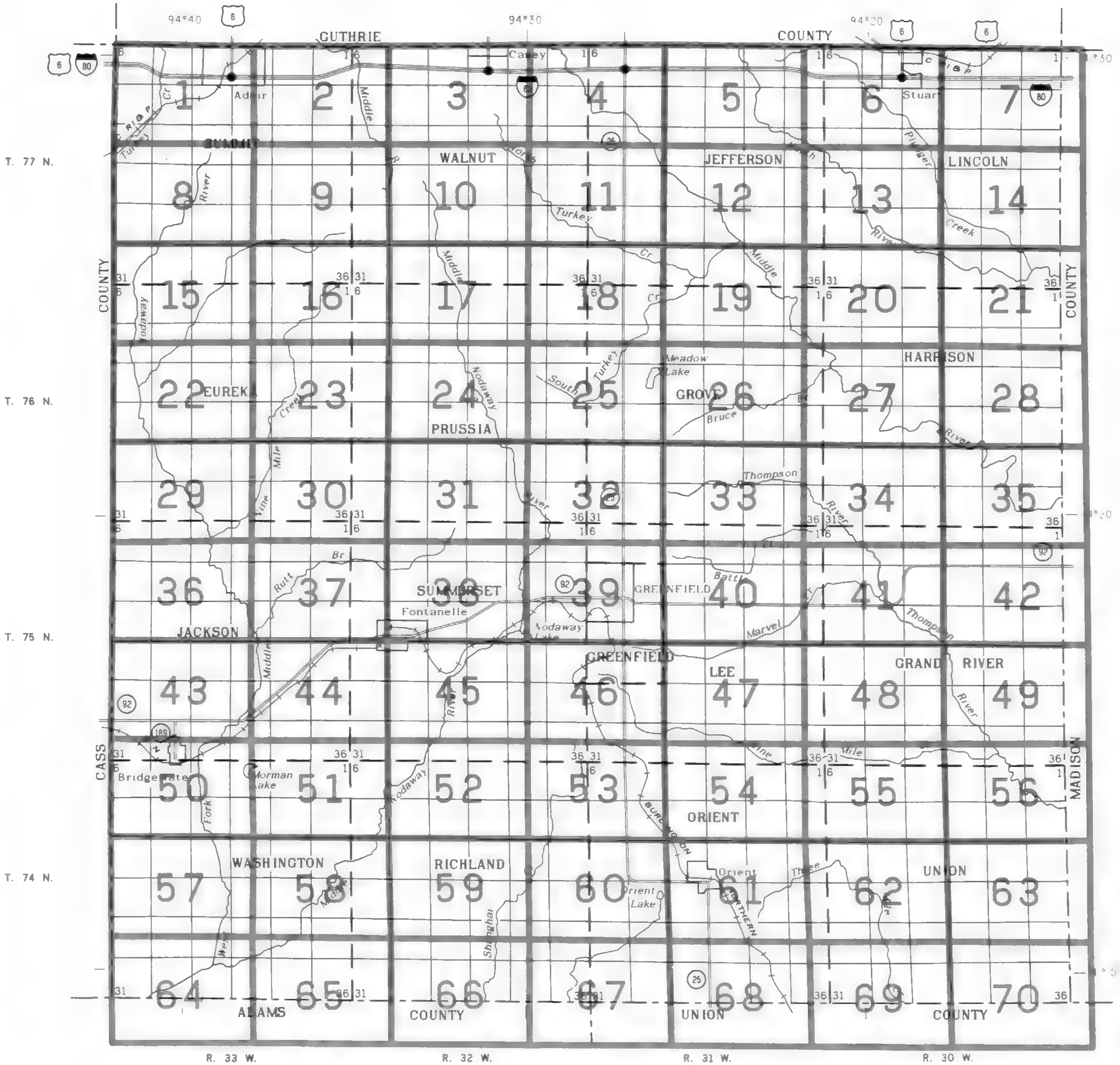
* The textures specified in this legend are those of the surface layer of the major soils in each map unit.

Compiled 1978

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



INDEX TO MAP SHEETS

ADAIR COUNTY, IOWA

Scale 1: 190,080

Original text from each individual map sheet read:
This map is compiled on 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Symbols consist of numbers or a combination of numbers and letters; for example 8B, 54, 175C2. The 1, 2, or 3 digit number designates the kind of soil or miscellaneous area. A capital letter B, C, D, E, F or G following a number indicates the class of slope. Most symbols without a slope letter are those for nearly level soils but some are for miscellaneous areas that have a considerable range of slope. A final number 2 or 3 following a letter indicates that the soil is moderately eroded or severely eroded respectively. A "+" used as a suffix to the soil symbol indicates an overwashed soil.

SYMBOL	NAME
8B	Judson silty clay loam, 2 to 5 percent slopes
8C	Judson silty clay loam, 5 to 9 percent slopes
11B	Colo–Ely silty clay loams, 2 to 5 percent slopes
13B	Vesser–Nodaway silt loams, 2 to 5 percent slopes
24C	Shelby clay loam, 5 to 9 percent slopes
24C2	Shelby clay loam, 5 to 9 percent slopes, moderately eroded
24D	Shelby clay loam, 9 to 14 percent slopes
24D2	Shelby clay loam, 9 to 14 percent slopes, moderately eroded
24E	Shelby clay loam, 14 to 18 percent slopes
24E2	Shelby clay loam, 14 to 18 percent slopes, moderately eroded
24F2	Shelby clay loam, 18 to 25 percent slopes, moderately eroded
51	Vesser silt loam, 0 to 2 percent slopes
54	Zook silty clay loam, 0 to 2 percent slopes
54+	Zook silt loam, overwash, 0 to 2 percent slopes
69C	Clearfield silty clay loam, 5 to 9 percent slopes
69C2	Clearfield silty clay loam, 5 to 9 percent slopes, moderately eroded
76B	Ladoga silt loam, 2 to 5 percent slopes
76C	Ladoga silt loam, 5 to 9 percent slopes
76C2	Ladoga silt loam, 5 to 9 percent slopes, moderately eroded
76D	Ladoga silt loam, 9 to 14 percent slopes
76D2	Ladoga silt loam, 9 to 14 percent slopes, moderately eroded
80C	Clinton silt loam, 5 to 9 percent slopes
80D2	Clinton silt loam, 9 to 14 percent slopes, moderately eroded
80E2	Clinton silt loam, 14 to 18 percent slopes, moderately eroded
93D2	Shelby–Adair clay loams, 9 to 14 percent slopes, moderately eroded
93E2	Shelby–Adair clay loams, 14 to 18 percent slopes, moderately eroded
133	Colo silty clay loam, 0 to 2 percent slopes
133+	Colo silt loam, overwash, 0 to 2 percent slopes
175C2	Dickinson fine sandy loam, 5 to 9 percent slopes, moderately eroded
175D2	Dickinson fine sandy loam, 9 to 14 percent slopes, moderately eroded
179D	Gara loam, 9 to 14 percent slopes
179D2	Gara loam, 9 to 14 percent slopes, moderately eroded
179E2	Gara loam, 14 to 18 percent slopes, moderately eroded
179F2	Gara loam, 18 to 25 percent slopes, moderately eroded
192C2	Adair clay loam, 5 to 9 percent slopes, moderately eroded
192D2	Adair clay loam, 9 to 14 percent slopes, moderately eroded
212	Kennebec silt loam, 0 to 2 percent slopes
220	Nodaway silt loam, 0 to 2 percent slopes
222C	Clarinda silty clay loam, 5 to 9 percent slopes
222C2	Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded

SYMBOL	NAME
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded
269	Humeston silt loam, 0 to 2 percent slopes
273B	Olmitz loam, 2 to 5 percent slopes
273C	Olmitz loam, 5 to 9 percent slopes
287B	Zook–Colo–Ely silty clay loams, 2 to 5 percent slopes
315	Nodaway soils, frequently flooded, 0 to 2 percent slopes
368	Macksburg silty clay loam, 0 to 2 percent slopes
368B	Macksburg silty clay loam, 2 to 5 percent slopes
369	Winterset silty clay loam, 0 to 2 percent slopes
370	Sharpsburg silty clay loam, 0 to 2 percent slopes
370B	Sharpsburg silty clay loam, 2 to 5 percent slopes
370C	Sharpsburg silty clay loam, 5 to 9 percent slopes
370C2	Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded
370D	Sharpsburg silty clay loam, 9 to 14 percent slopes
370D2	Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded
412G	Sogn soils, 25 to 40 percent slopes
428B	Ely silty clay loam, 2 to 5 percent slopes
430	Ackmore silty clay loam, 0 to 2 percent slopes
434D	Arbor loam, 9 to 14 percent slopes
451D2	Caleb loam, 9 to 14 percent slopes, moderately eroded
570B	Nira silty clay loam, 2 to 5 percent slopes
570C	Nira silty clay loam, 5 to 9 percent slopes
570C2	Nira silty clay loam, 5 to 9 percent slopes, moderately eroded
570D2	Nira silty clay loam, 9 to 14 percent slopes, moderately eroded
675C	Dickinson–Sharpsburg complex, 5 to 9 percent slopes
675D2	Dickinson–Sharpsburg complex, 9 to 14 percent slopes, moderately eroded
792D2	Armstrong loam, 9 to 14 percent slopes, moderately eroded
822C	Lamoni silty clay loam, 5 to 9 percent slopes
822C2	Lamoni silty clay loam, 5 to 9 percent slopes, moderately eroded
822D	Lamoni silty clay loam, 9 to 14 percent slopes
822D2	Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded
822D3	Lamoni clay, 9 to 14 percent slopes, severely eroded
870B	Sharpsburg silty clay loam, benches, 2 to 5 percent slopes
876B	Ladoga silt loam, benches, 2 to 5 percent slopes
876C	Ladoga silt loam, benches, 5 to 9 percent slopes
993D2	Gara–Armstrong loams, 9 to 14 percent slopes, moderately eroded
993E2	Gara–Armstrong loams, 14 to 18 percent slopes, moderately eroded
993F2	Gara–Armstrong loams, 18 to 25 percent slopes, moderately eroded
5030	Pits–Dumps complex

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 133; 76C2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

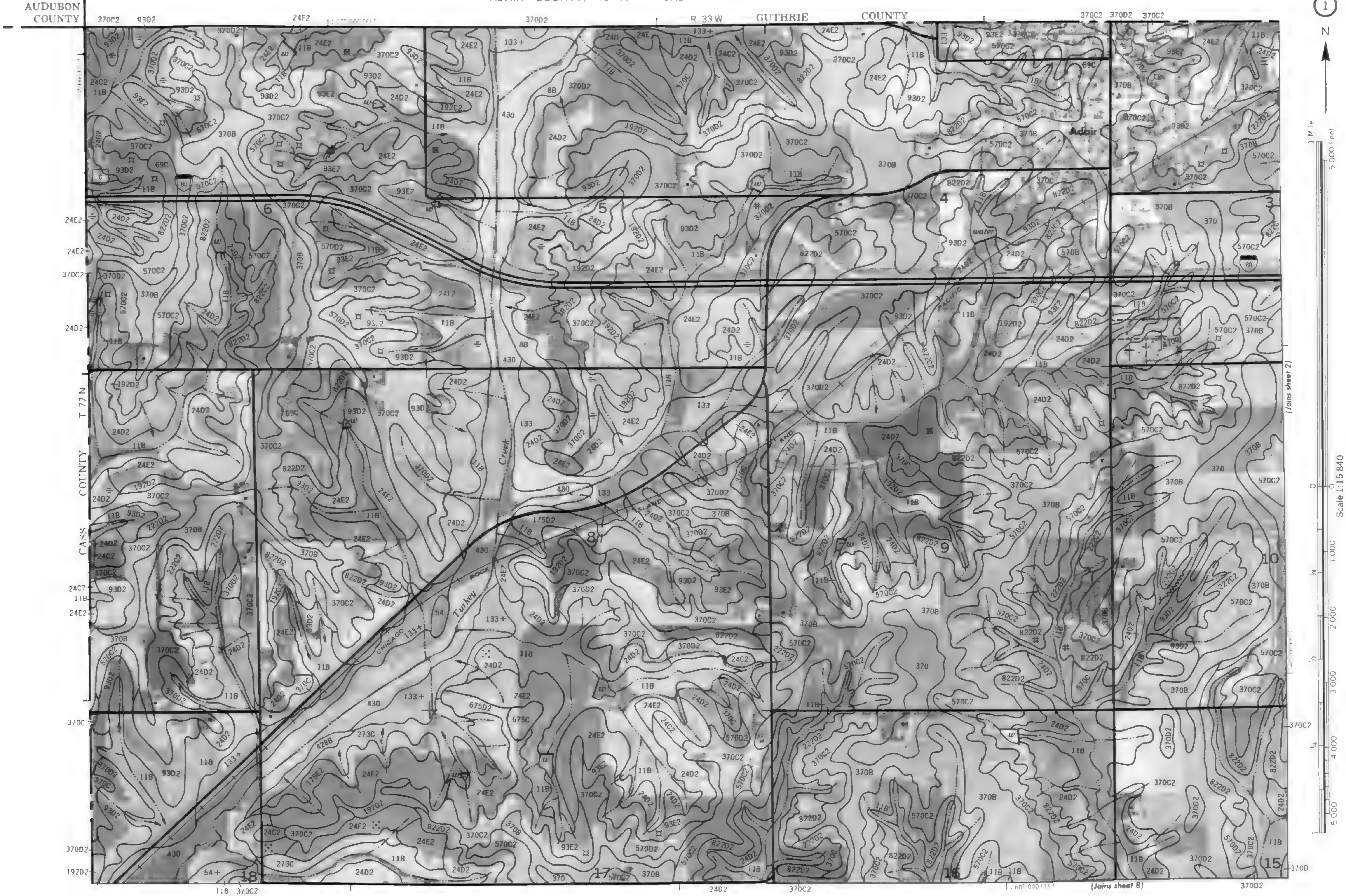
DEPRESSION OR SINK

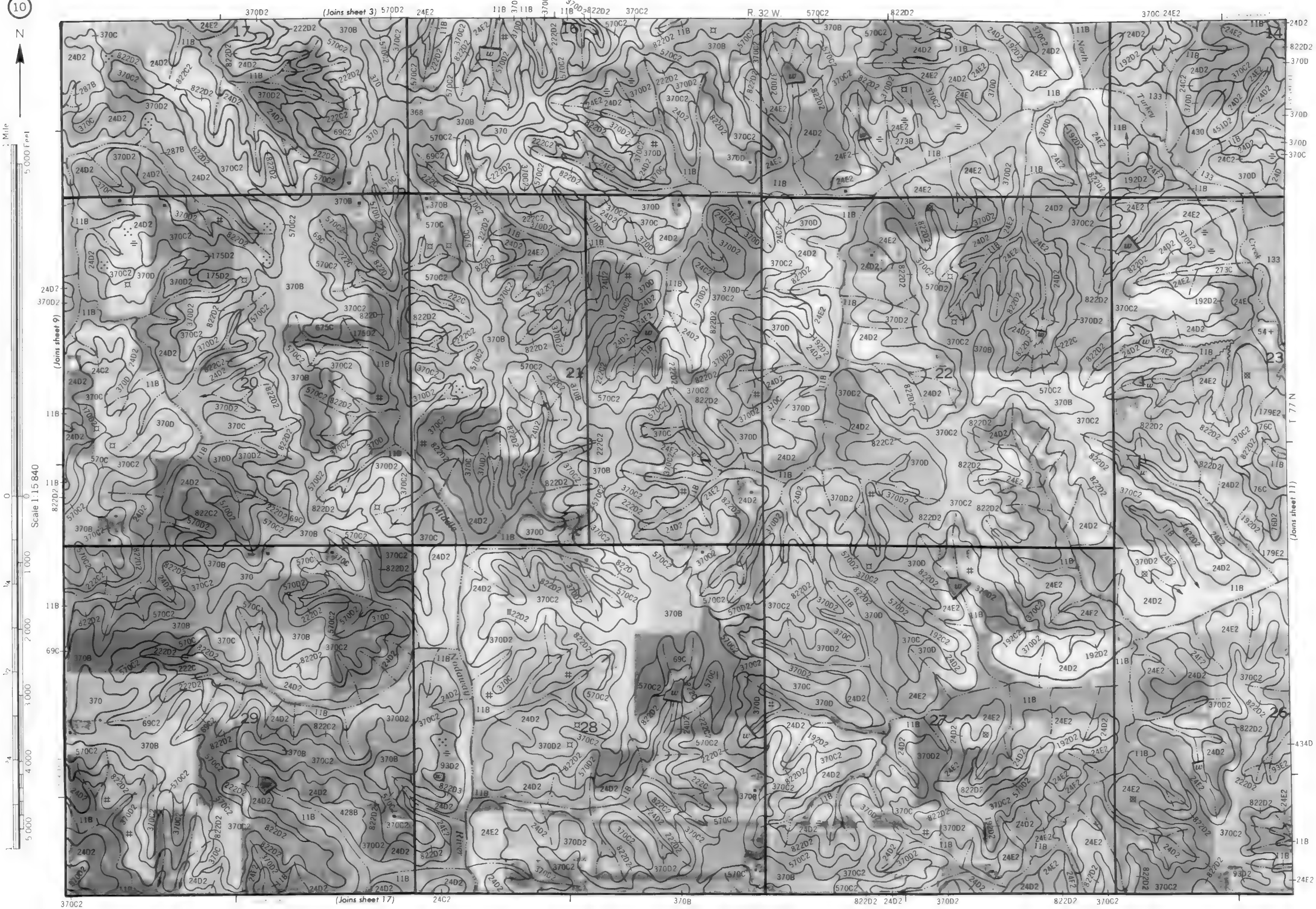
SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Clarinada soil area up to 2 acres in size
- Adair soil area up to 2 acres in size
- Calcareous spot
- Glacial till spot
- Sewage lagoon — SL

ADAIR COUNTY, IOWA — SHEET NUMBER 1




10
N
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(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 17)
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T. 77 N.
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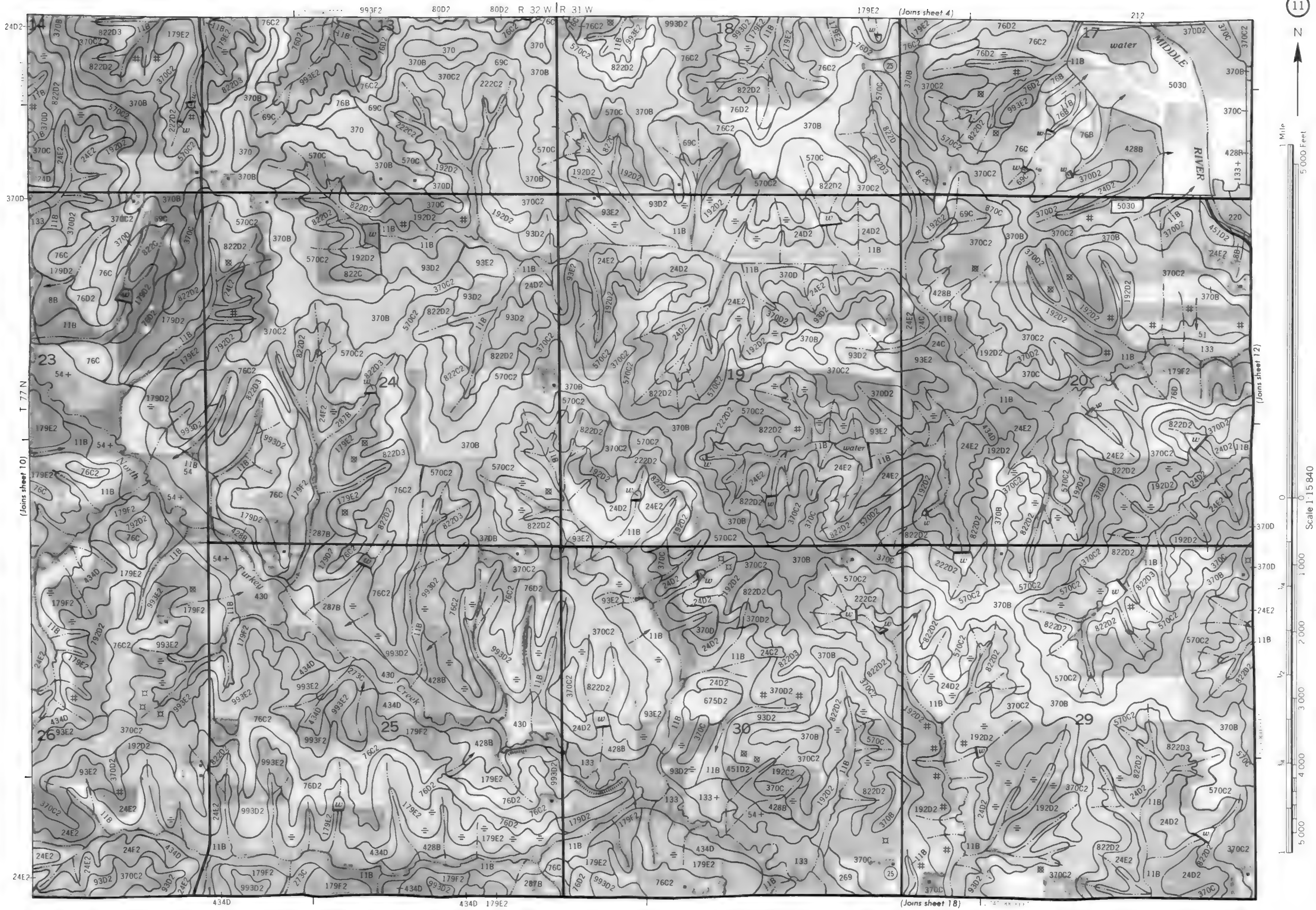
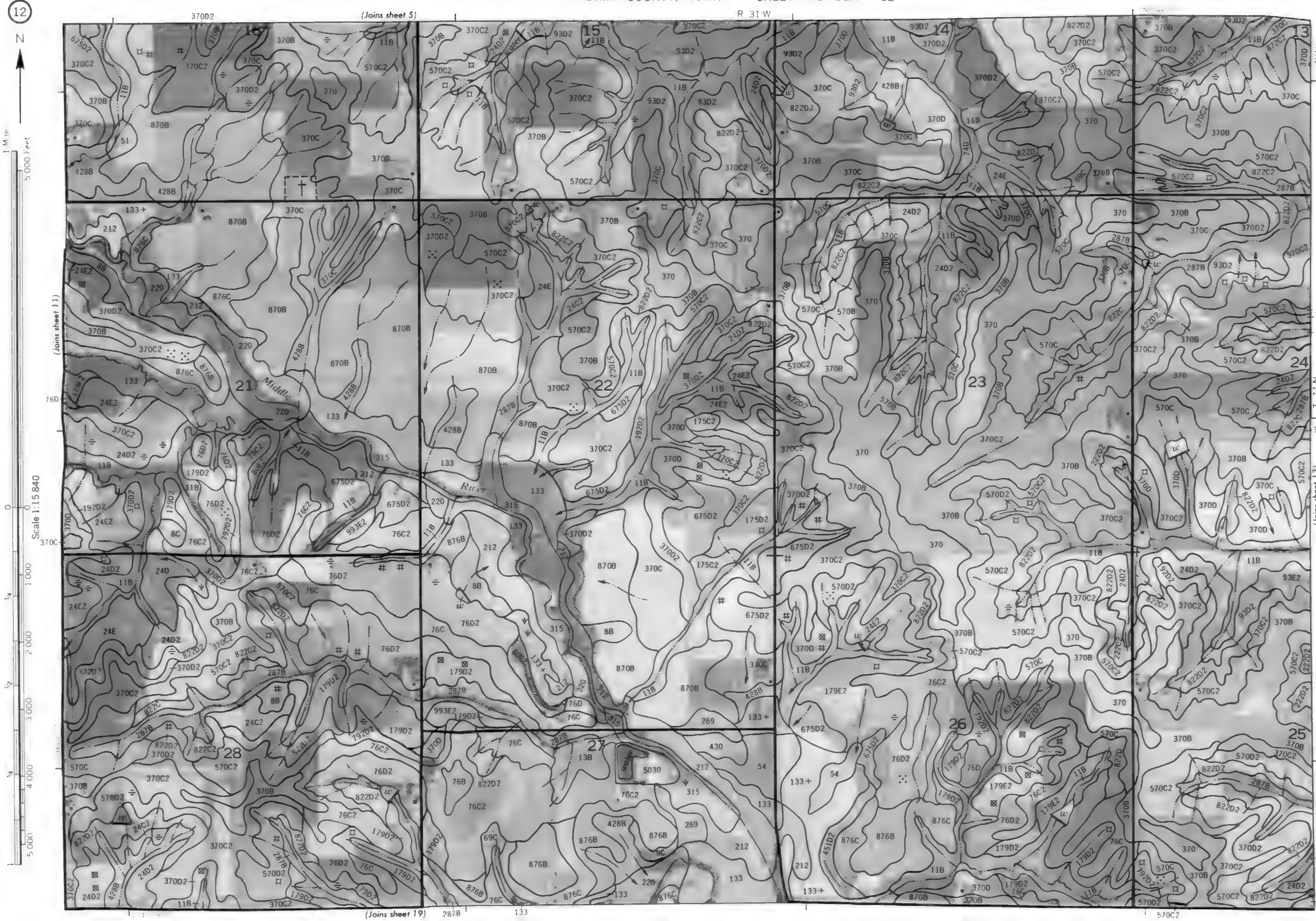
1 Mile
5 000 Feet
Middle
Nodaway
River
North
Turkey
Creek


11
R 32 W | R 31 W
(Joins sheet 4)
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 18)
T 77 N
N
MIDDLE RIVER
North
Turkey Creek
water
1 Mile
5 000 Feet
Scale 1:15 840


12
N
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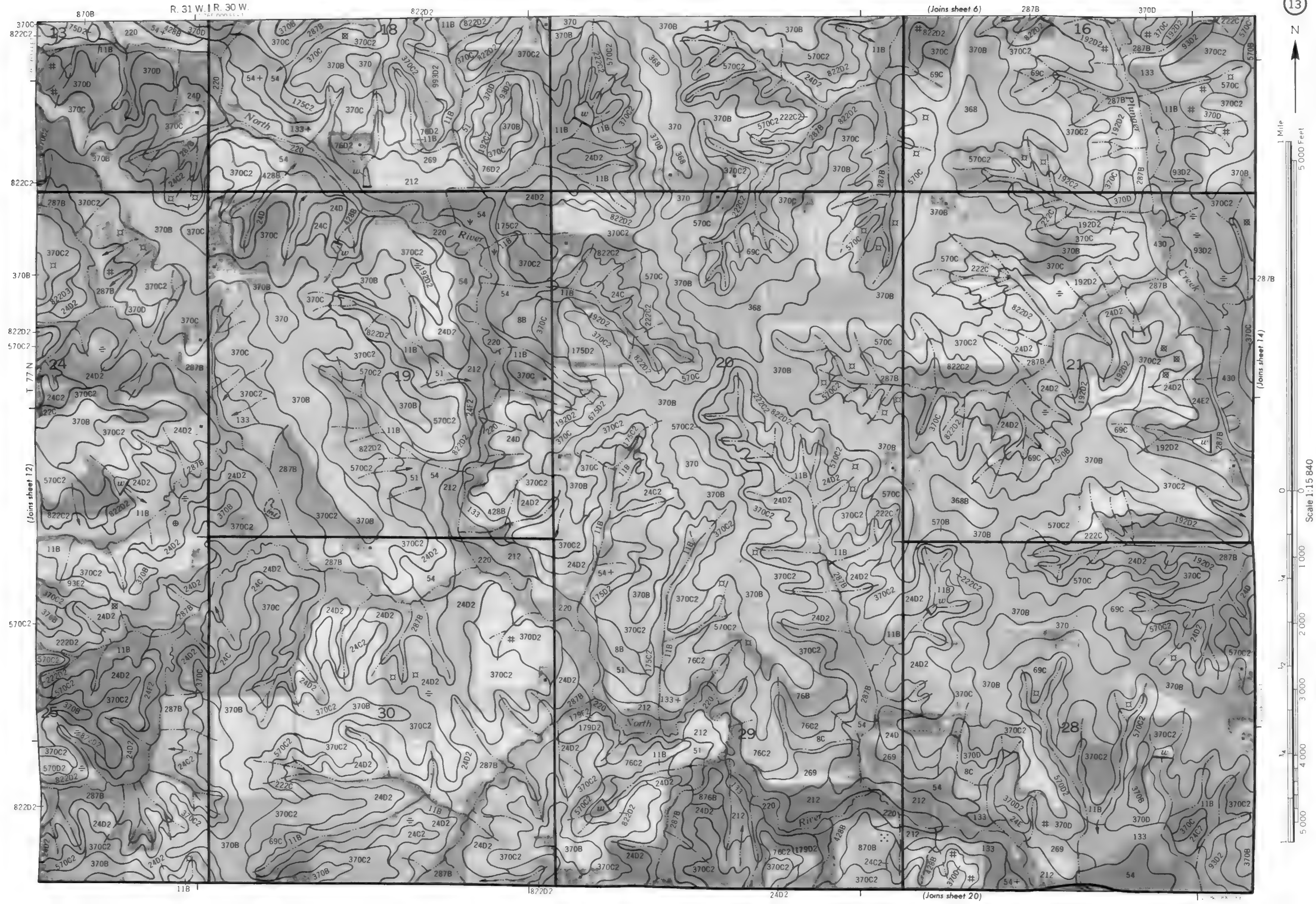
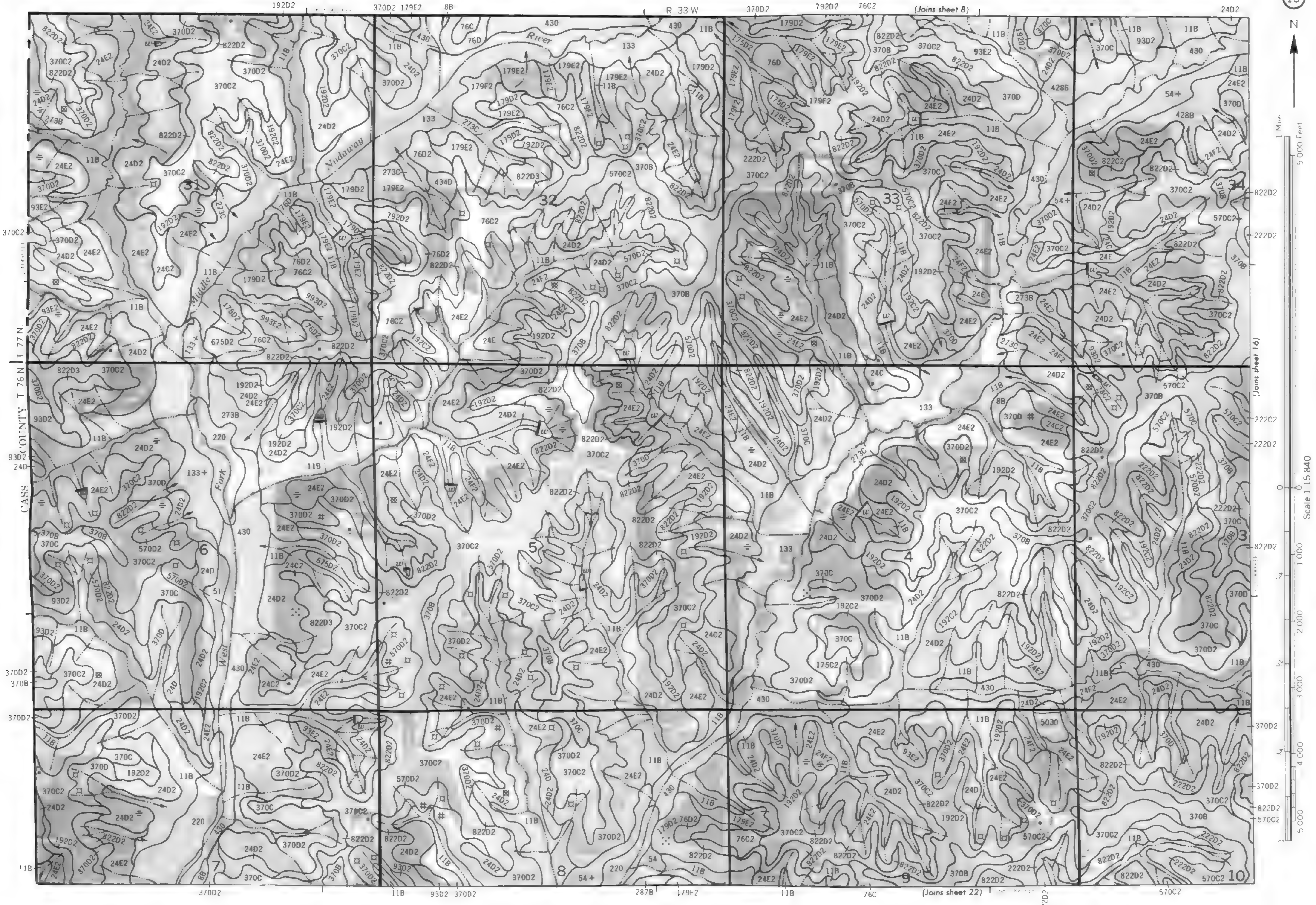
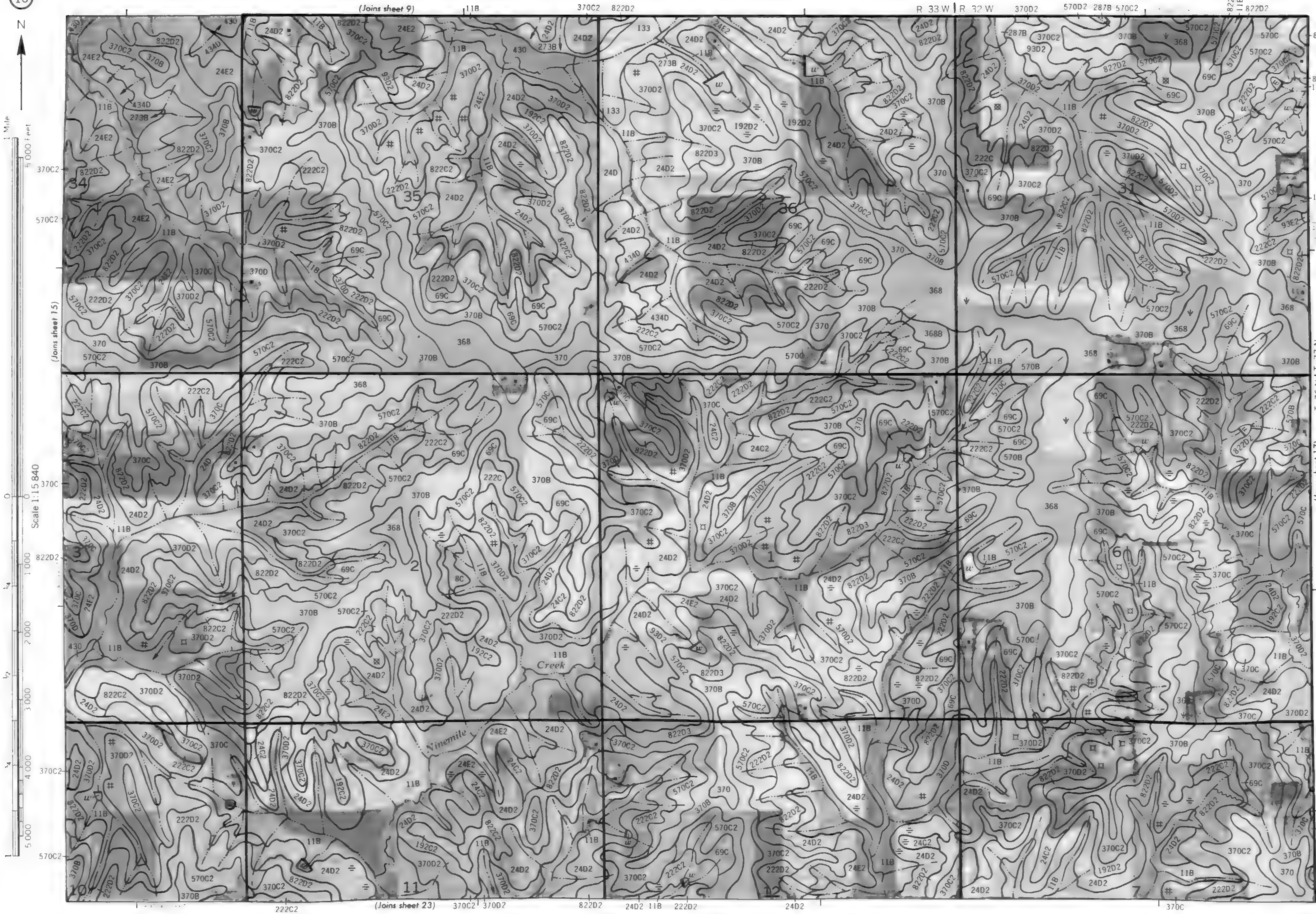
R 31 W
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 19)
T 77 N
Scale 1:15 840
1 Mile
5 000 Feet
16
15
14
13
21
22
23
24
28
27
26
25
Middle
River

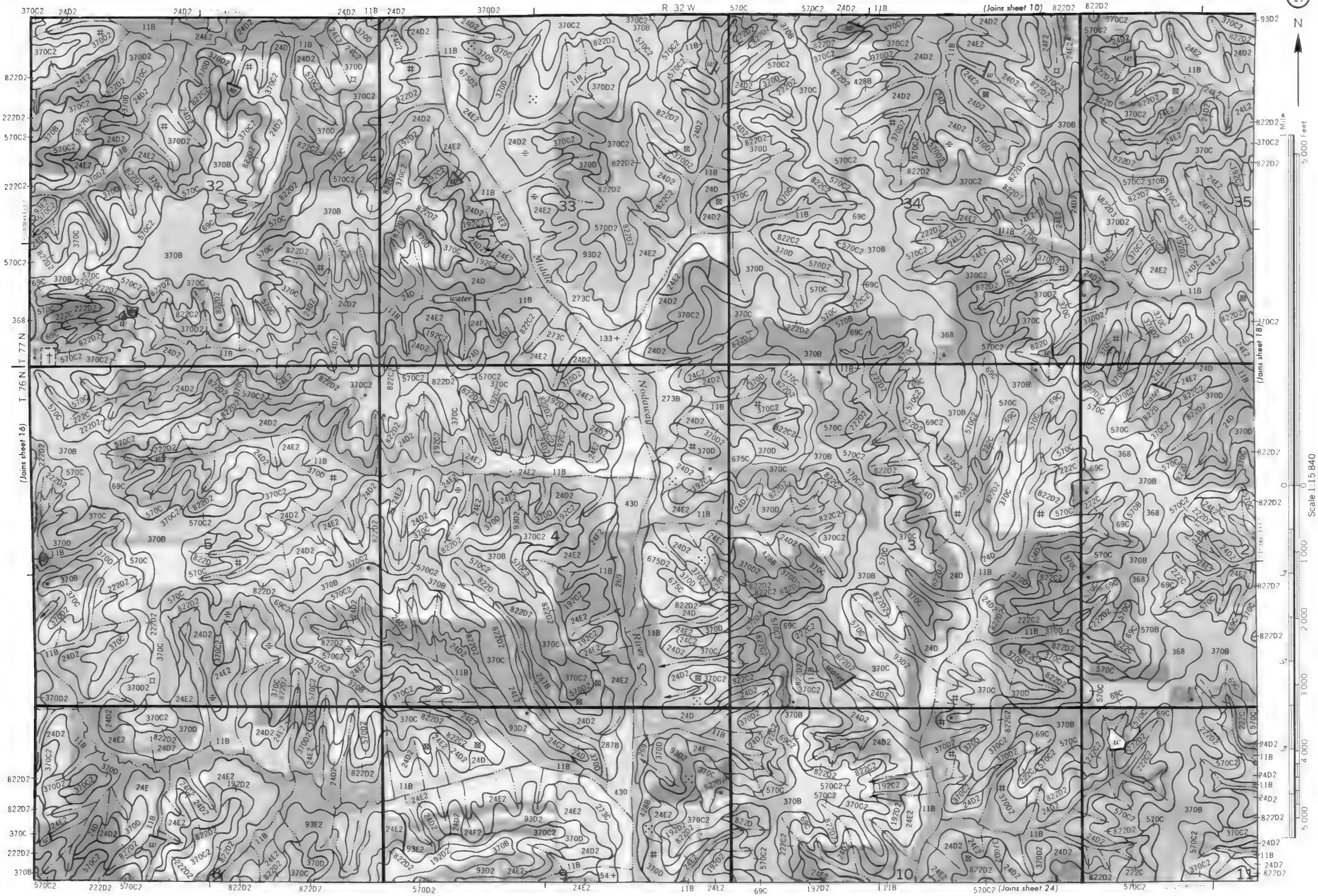

R. 31 W. | R. 30 W.
(Joins sheet 6)
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 20)
T. 77 N.
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
North River
Creek
13
18
17
16
24
19
20
21
25
30
29
28

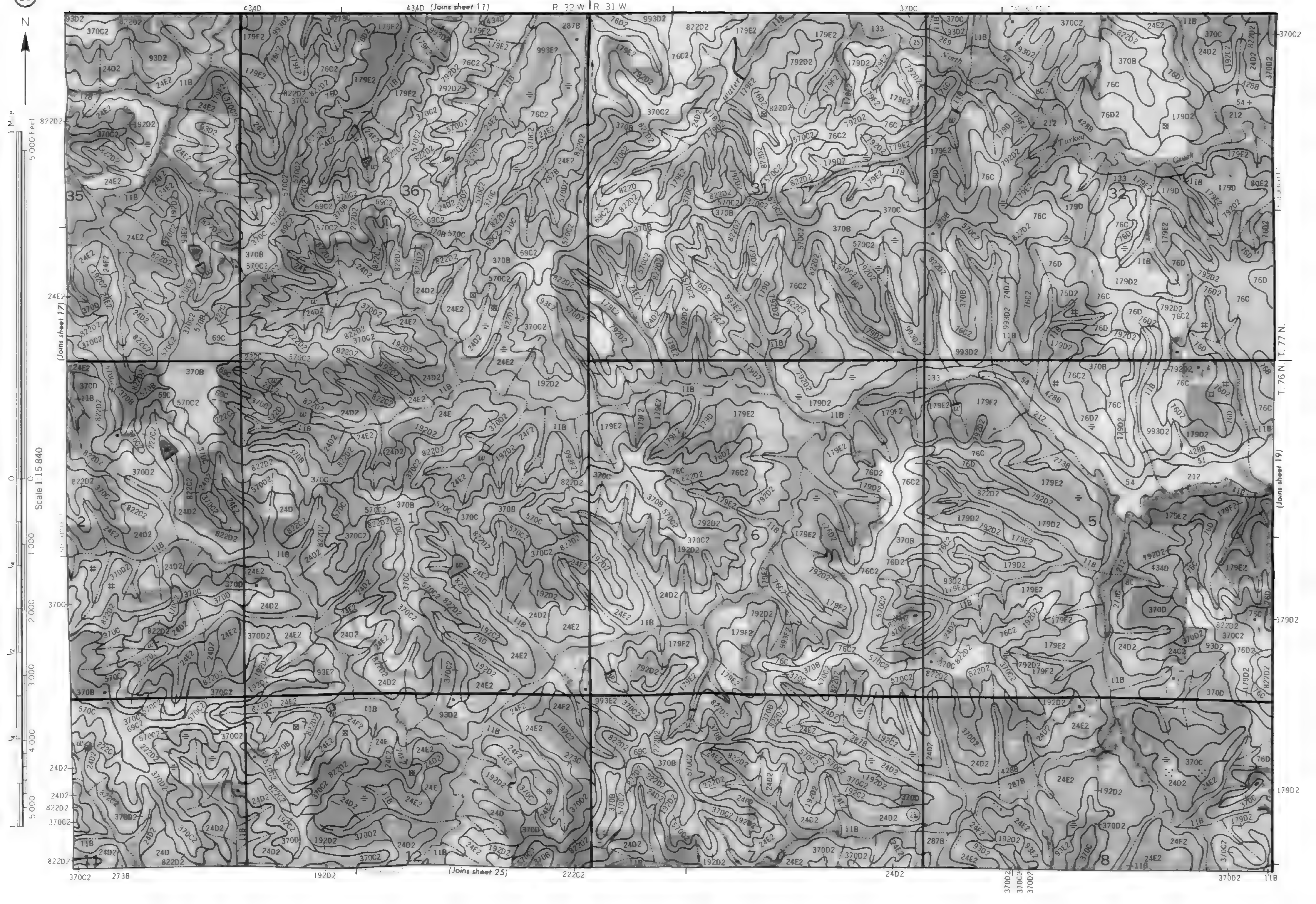

(Joins sheet 7)
R. 30 W.
(Joins sheet 13)
(Joins sheet 21)
MADISON COUNTY
T. 77 N.
N
1 Mile
5 000 Feet
Scale 1:15 840
Plunger
Creek
15
14
13
22
23
24
27
26
25


R 33 W.
(Joins sheet 8)
(Joins sheet 16)
(Joins sheet 22)
T 77 N.
T 76 N.
CASS COUNTY
Nodaway
River
Middle
Fork
West
31
32
33
34
6
5
4
3
7
8
9
10
N
1 Mile
5 000 Feet
Scale 1:15 840

ADAIR COUNTY, IOWA — SHEET NUMBER 16




17
N
R. 32 W.
(Joins sheet 10)
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 24)
T 77 N
T 76 N
1 Mile
5 000 Feet
Scale 1:15 840
32
33
34
35
5
4
3
2
8
9
10
11
Middle
Nodaway
River
water


N
(Joins sheet 11)
R. 32 W.
R. 31 W.
T. 77 N.
T. 76 N.
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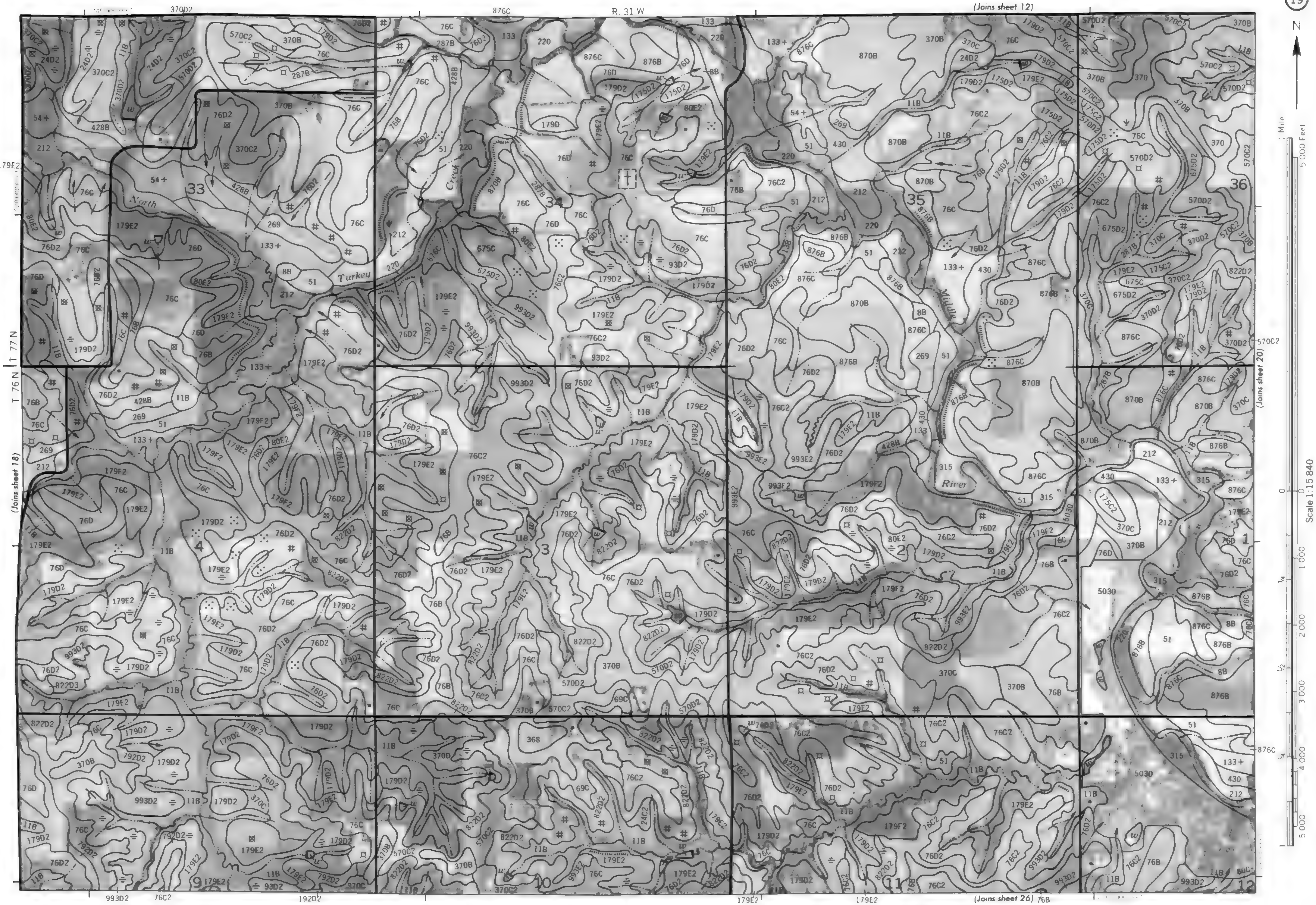
(Joins sheet 19)
(Joins sheet 25)
Scale 1:15 840
1 Mile
5 000 Feet
North
Turkey
Creek
Water


19
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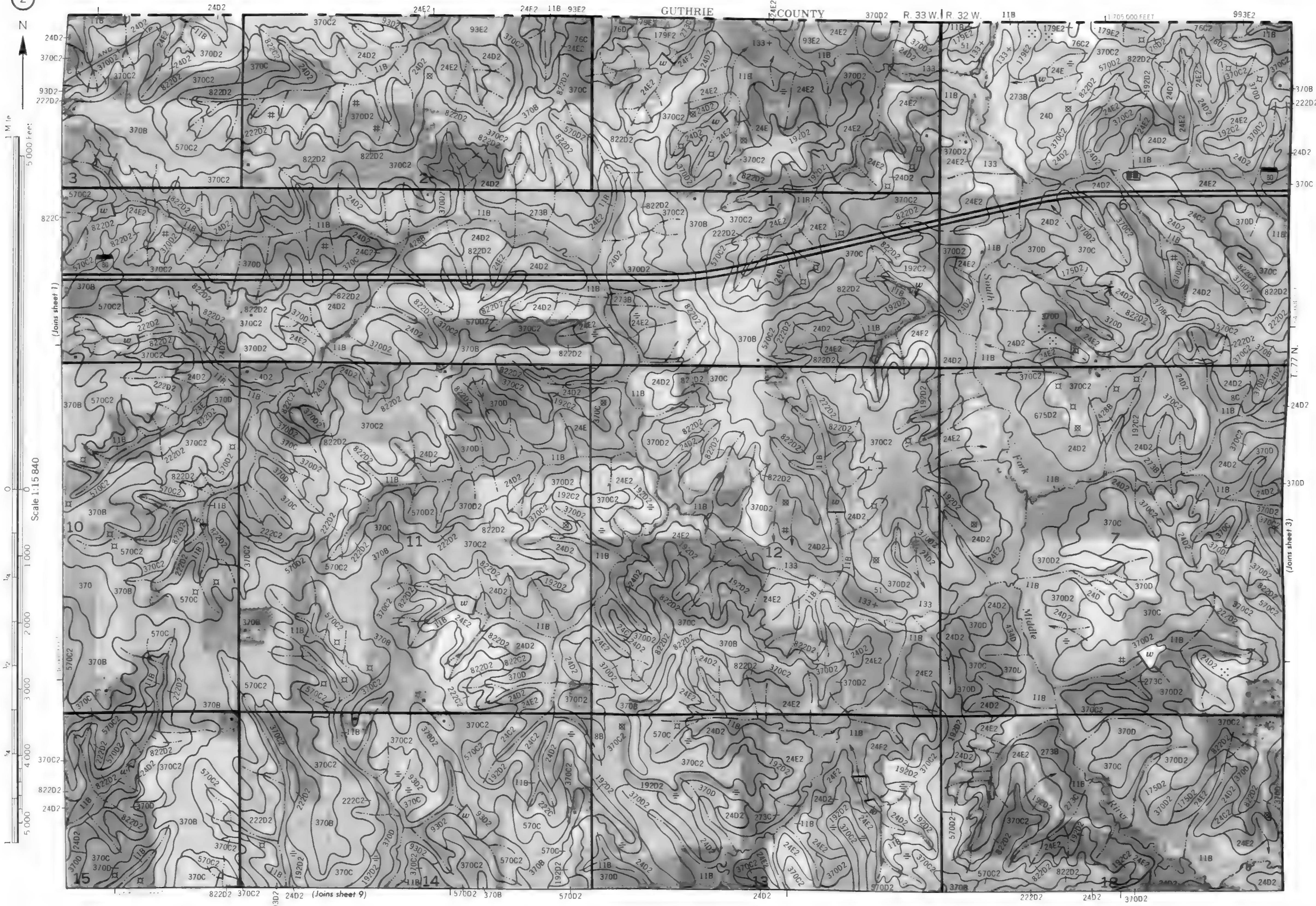
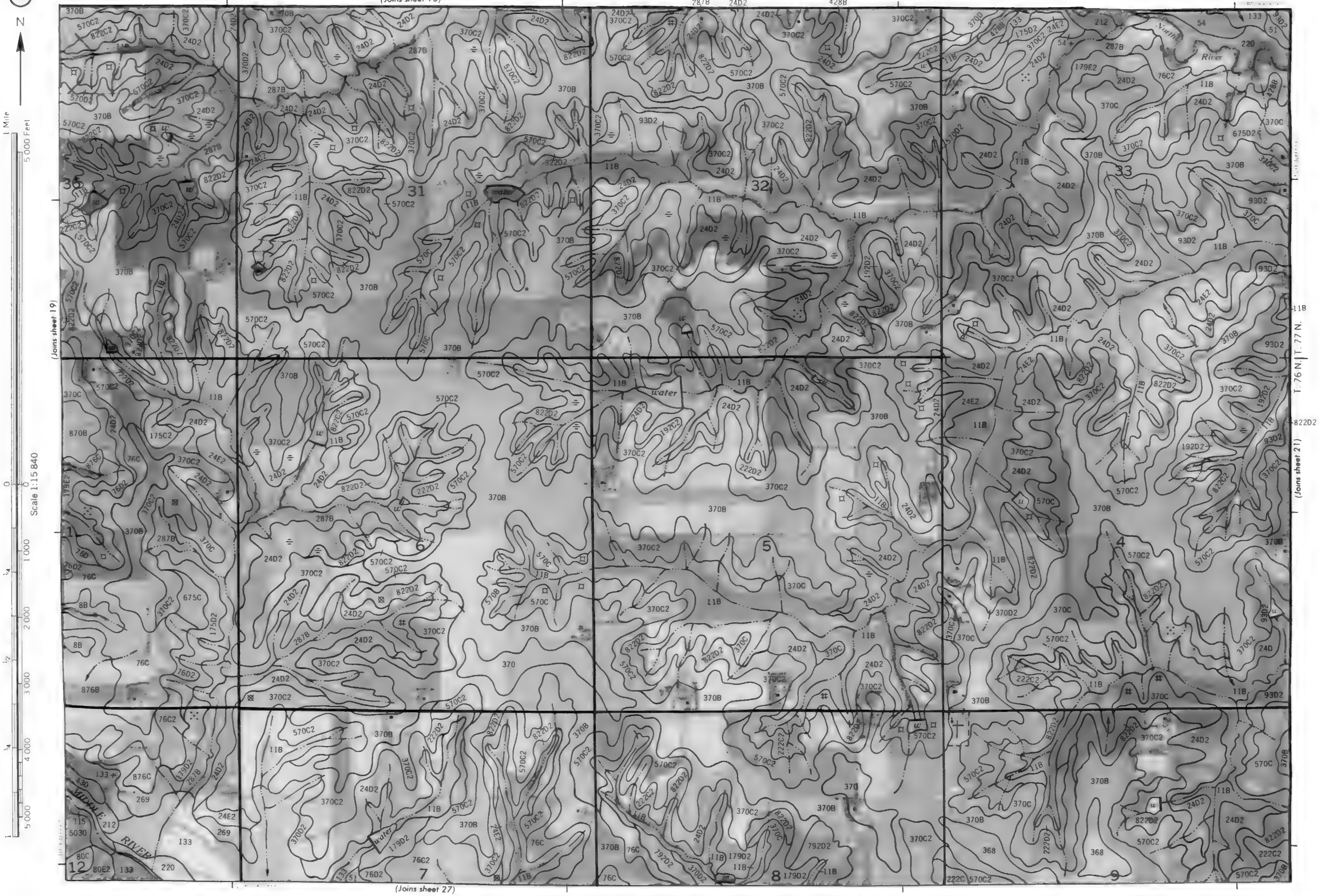
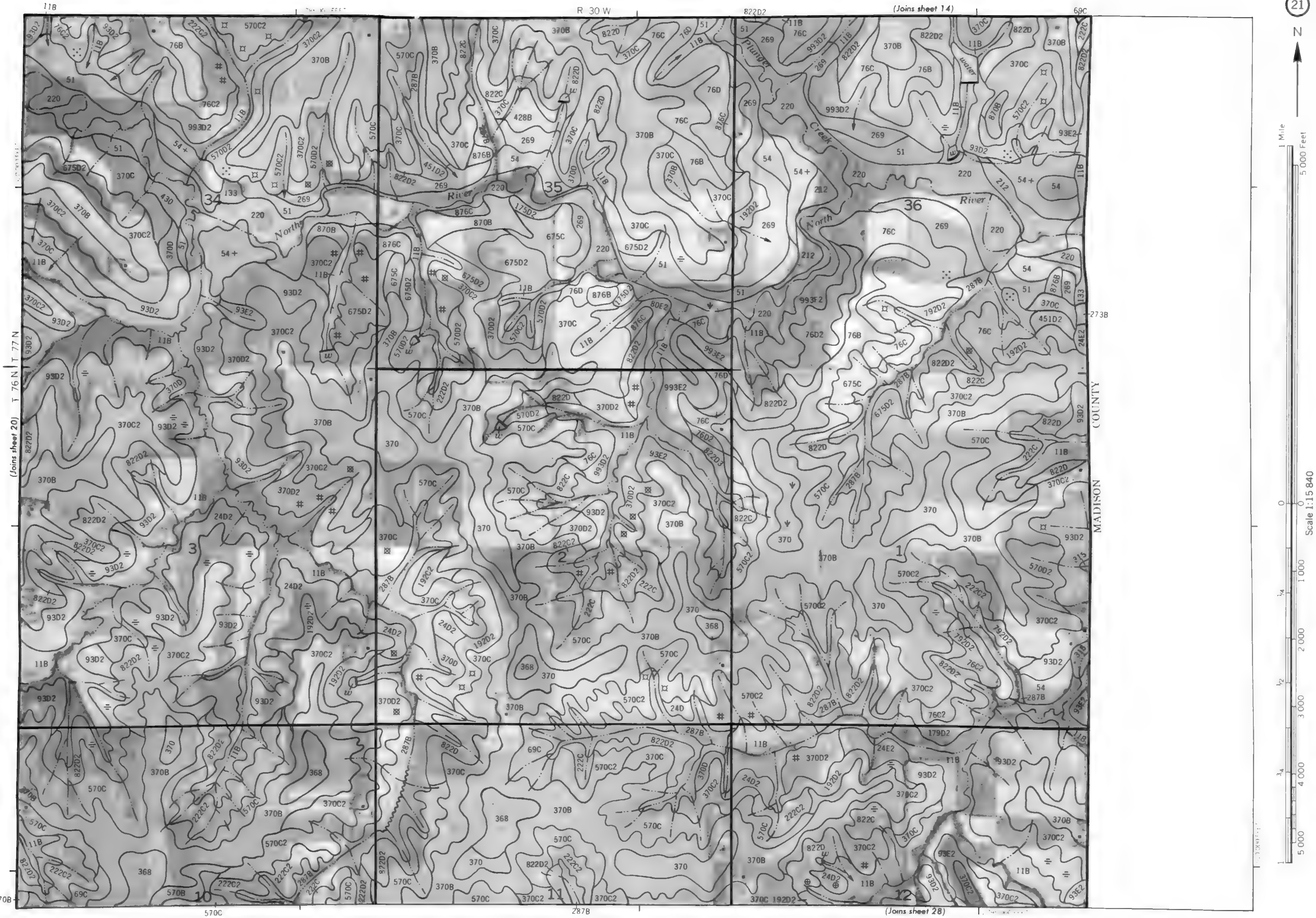
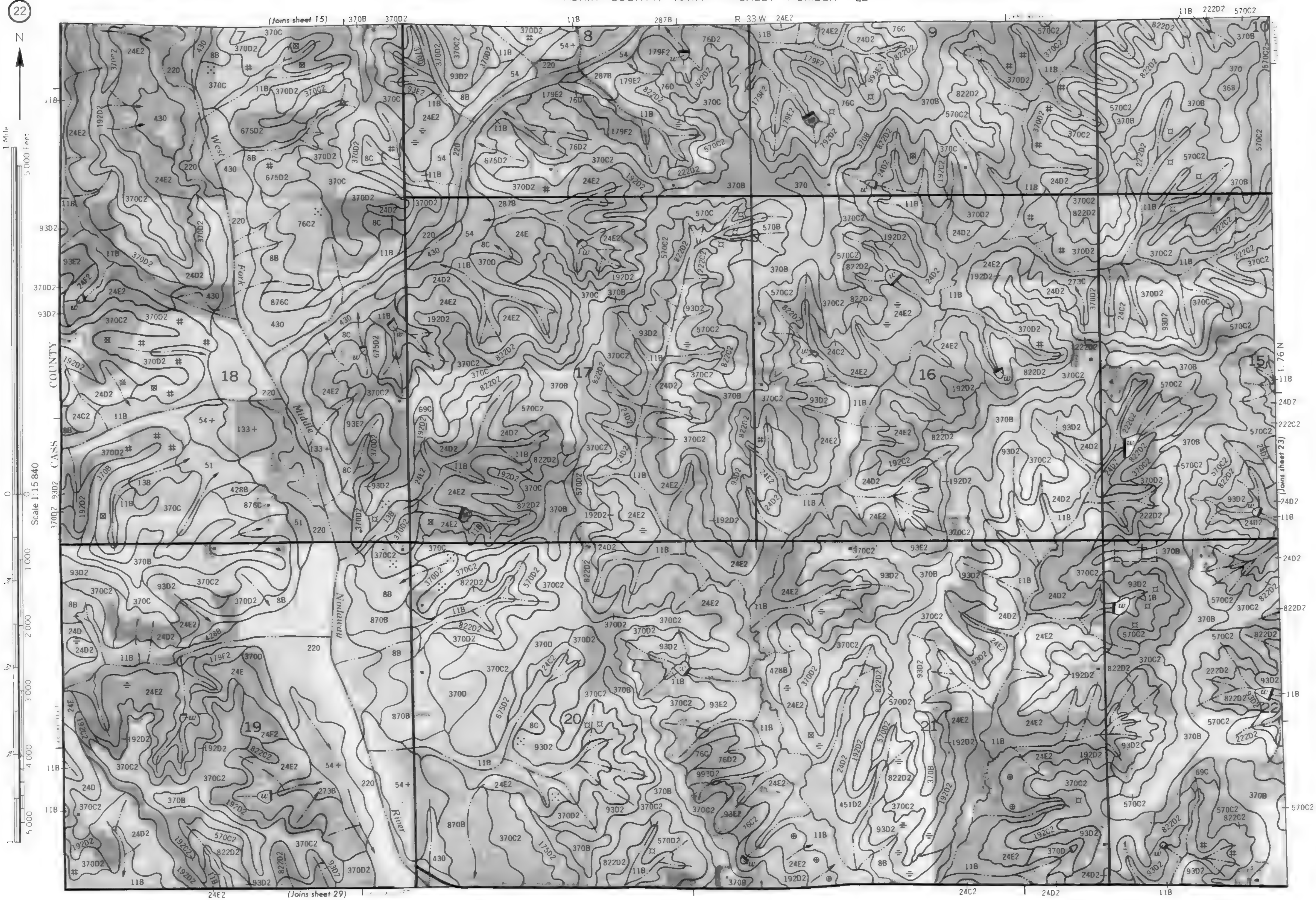
R. 31 W
N
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 26)
T 77 N
T 76 N
North
Turkey
Creek
Middle
River
33
34
35
36
4
3
2
1
9
10
11
12
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

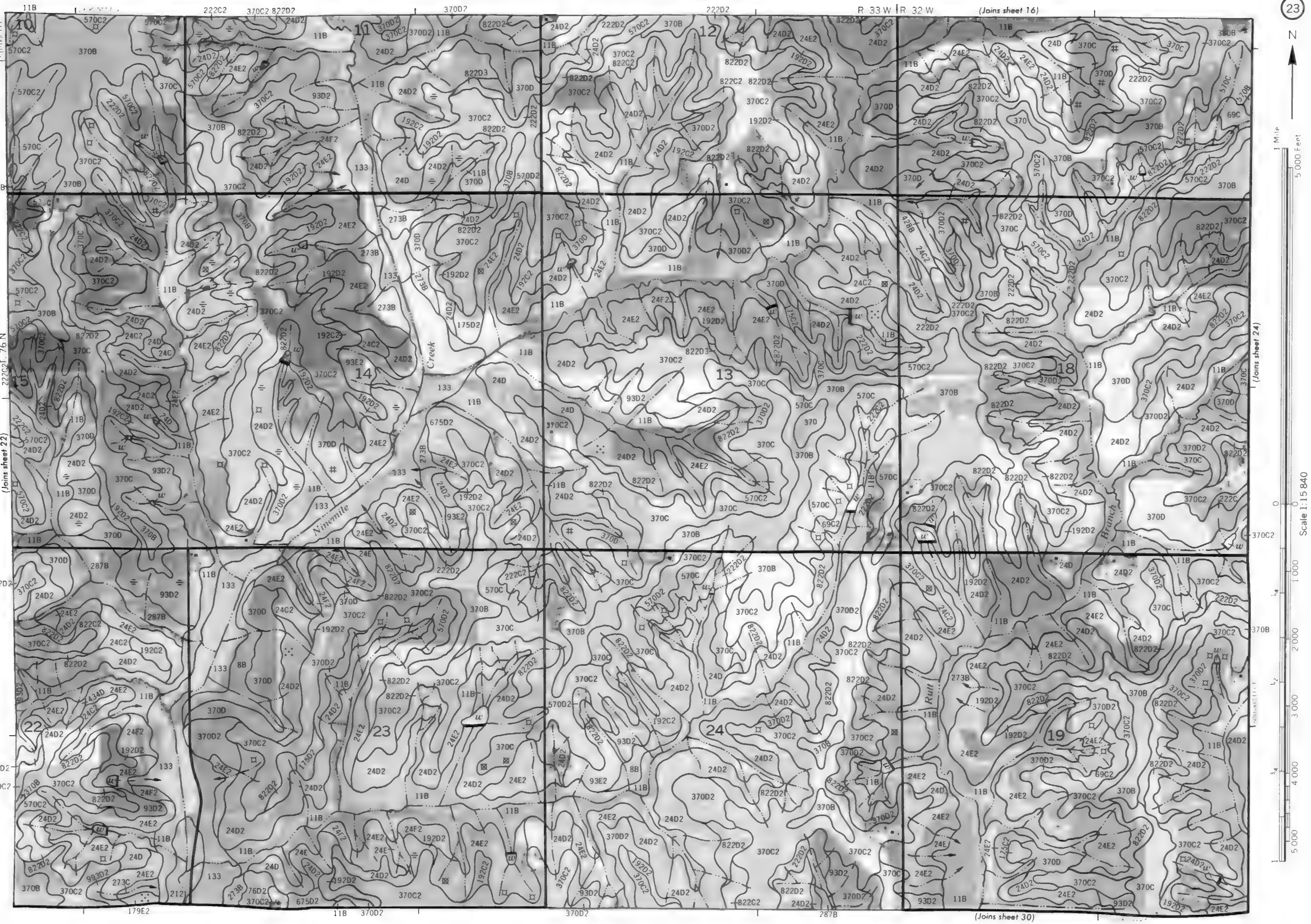
ADAIR COUNTY, IOWA — SHEET NUMBER 2

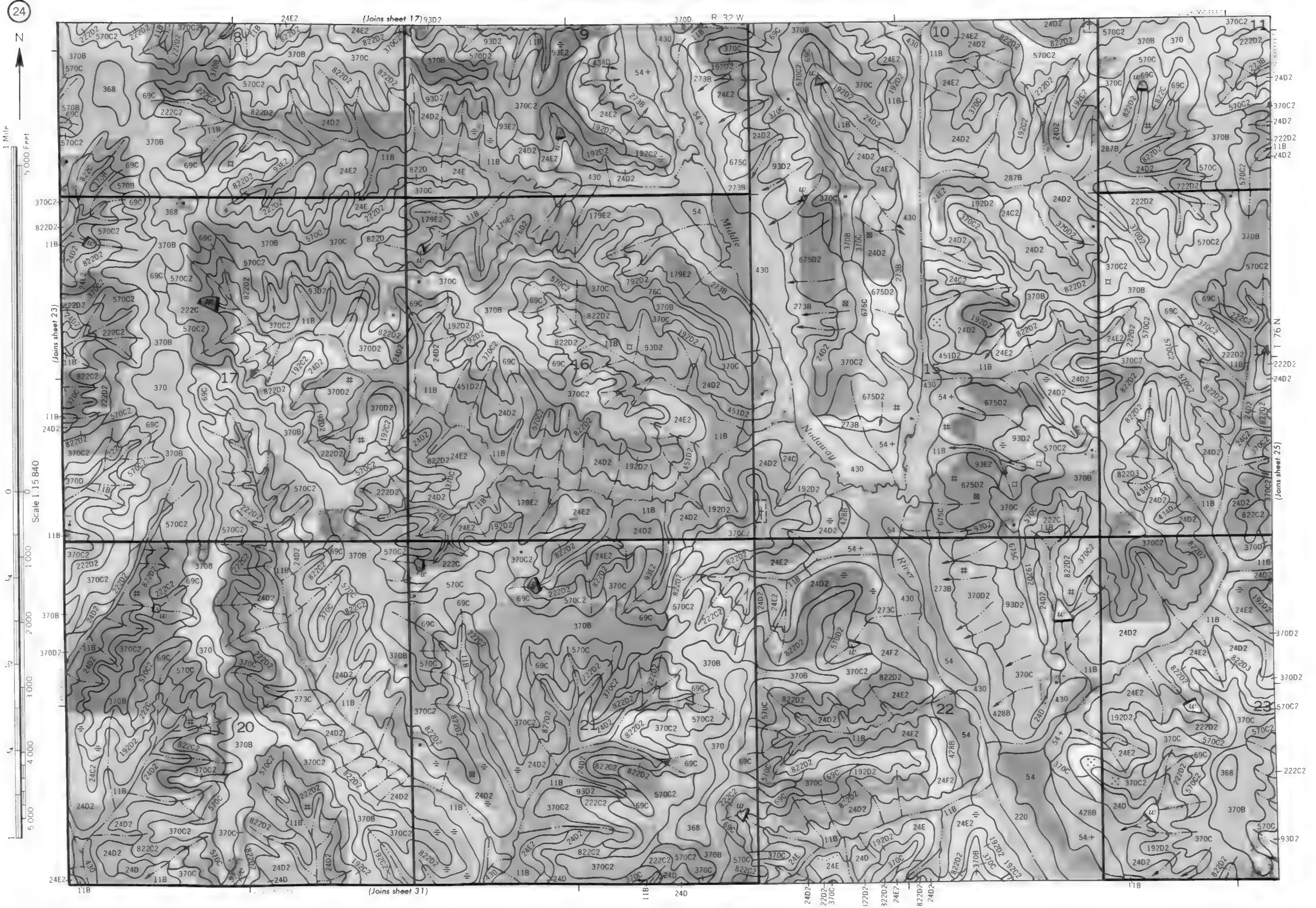



R. 31 W. | R. 30 W.
(Joins sheet 13)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 27)
T. 76 N. | T. 77 N.
N
1 Mile
5 000 Feet
Scale 1:15 840
North River
MIDDLE RIVER
water
36
31
32
33
1
6
5
4
12
7
8
9

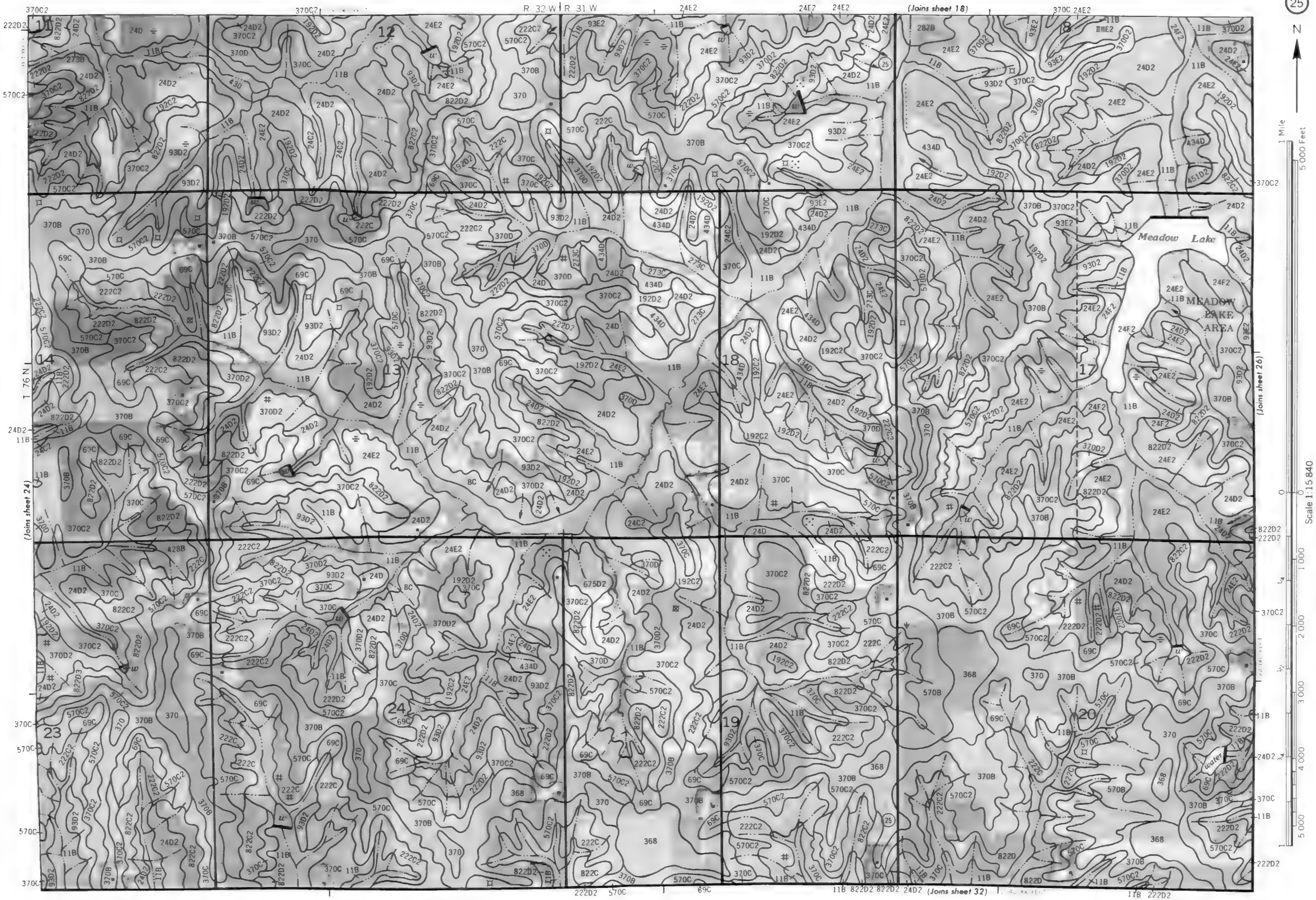

21
N
(Joins sheet 14)
R 30 W
(Joins sheet 20)
T 77 N
T 76 N
(Joins sheet 28)
MADISON COUNTY
North River
Plunger Creek
34
35
36
3
2
1
10
11
12
1 Mile
5 000 Feet
Scale 1:15 840

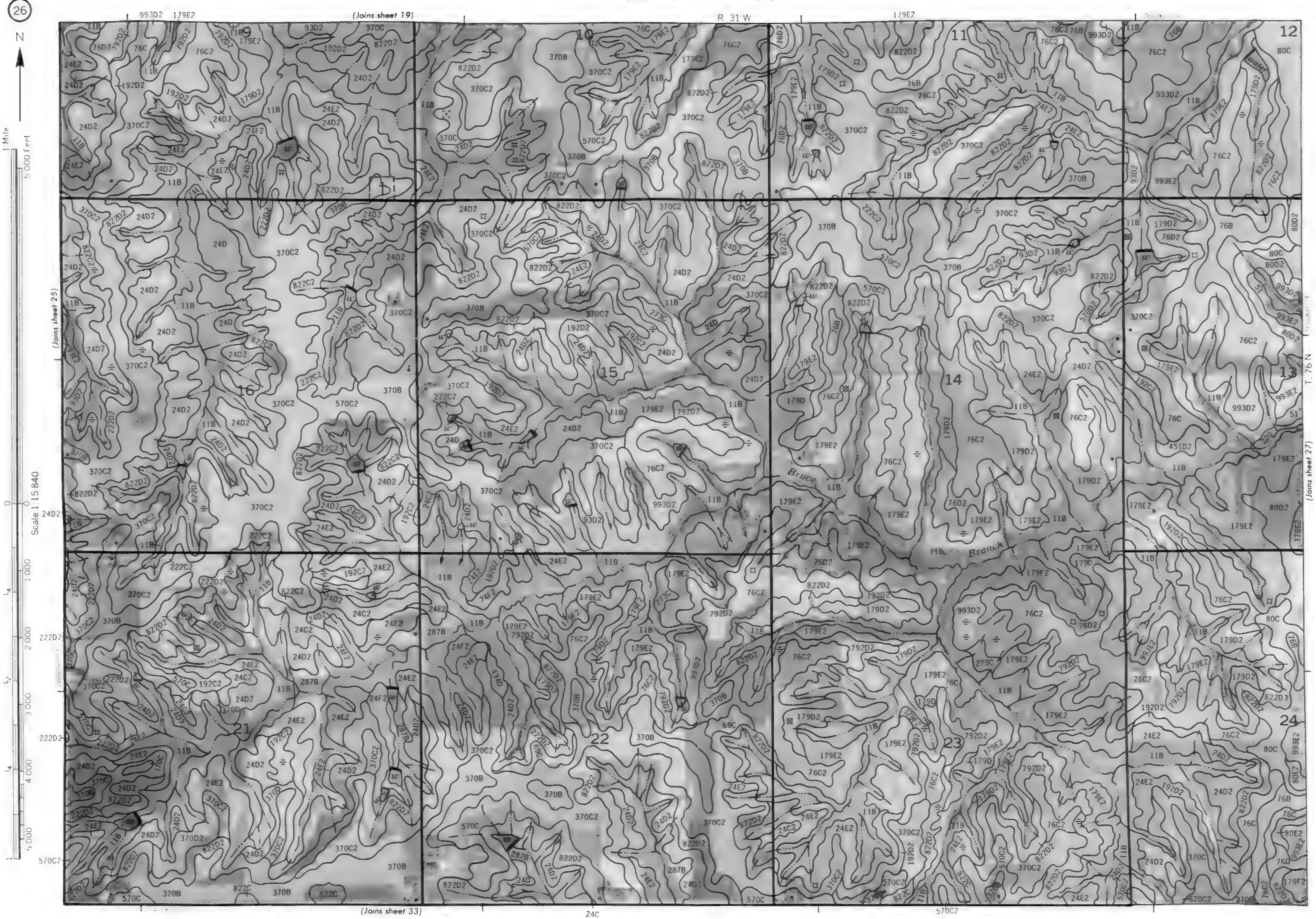

22
N
(Joins sheet 15)
R. 33 W.
T. 76 N.
(Joins sheet 23)
(Joins sheet 29)
CASS COUNTY
West Fork
Middle Nodaway River
Scale 1:15 840
1 Mile
5 000 Feet
7
8
9
10
15
16
17
18
19
20
21
22

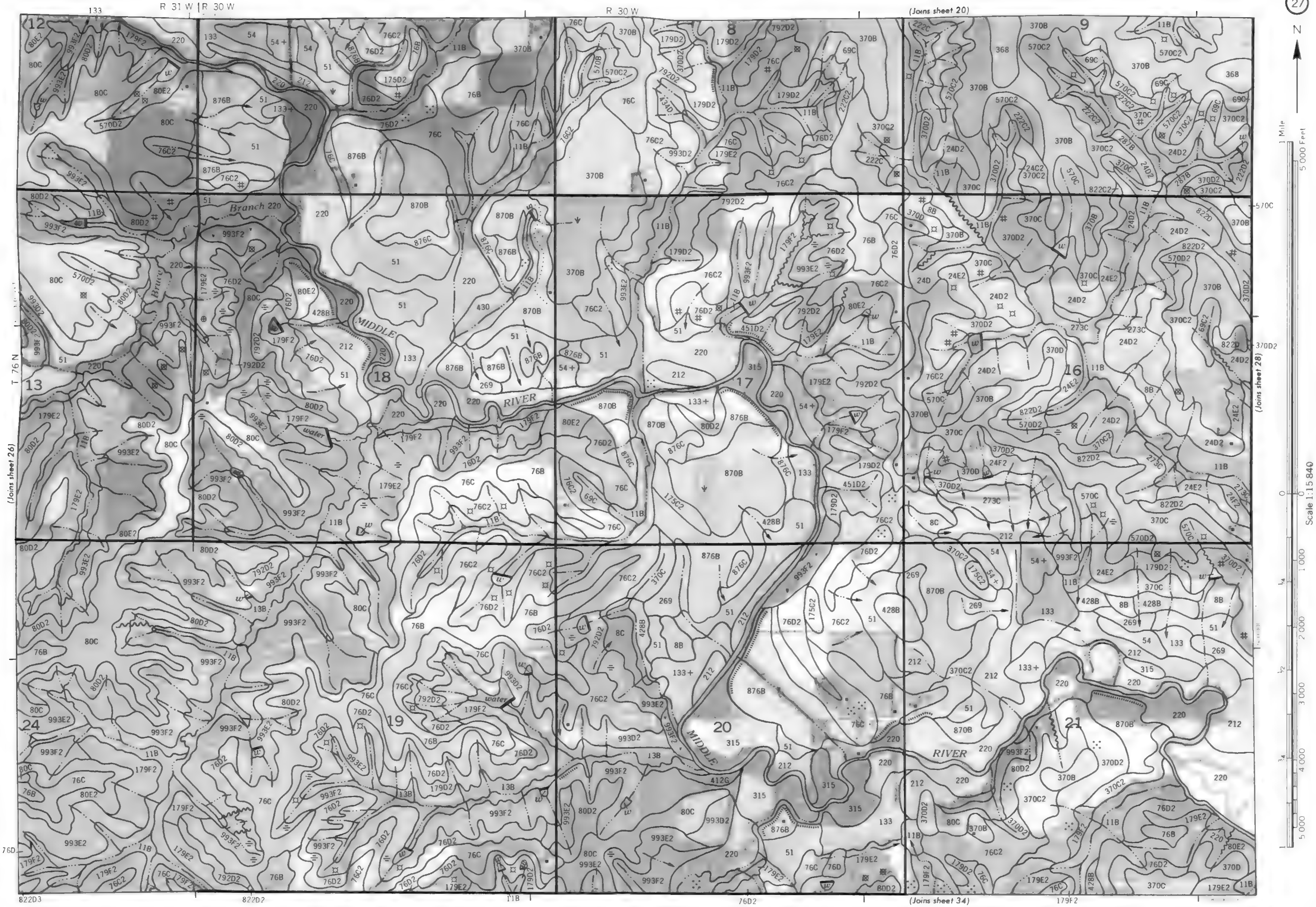

23
R. 33 W. | R. 32 W.
(Joins sheet 16)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 30)
T. 76 N.
N
1 Mile
5 000 Feet
Scale 1:15 840
Ninemile
Creek
Rutt
Branch
10
11
12
13
14
15
18
19
22
23
24


24
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
(Joins sheet 17)
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 31)
R. 32 W.
T. 76 N.
8
9
10
11
14
15
16
17
20
21
22
23
Middle
Nodaway
River

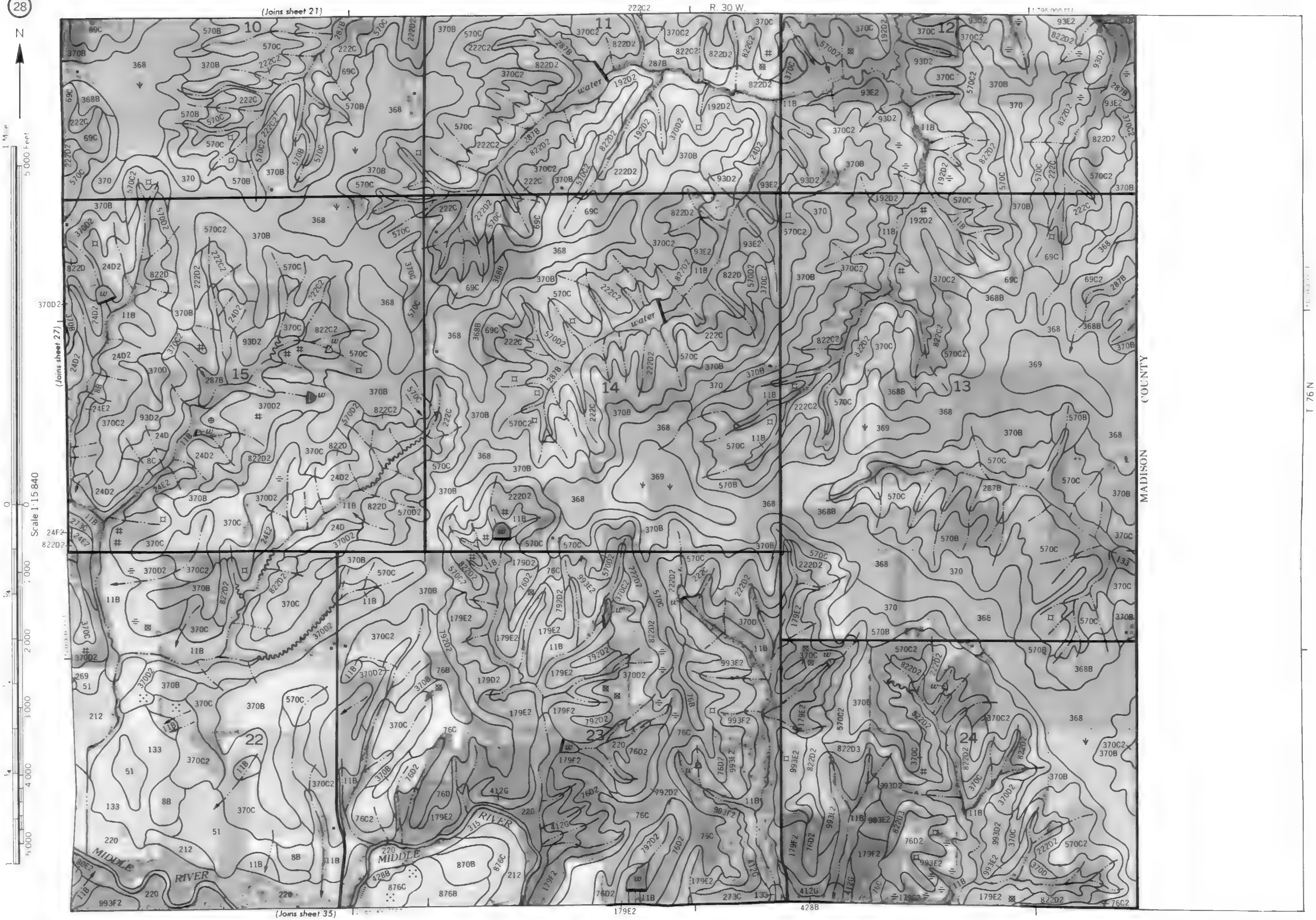
ADAIR COUNTY, IOWA — SHEET NUMBER 25

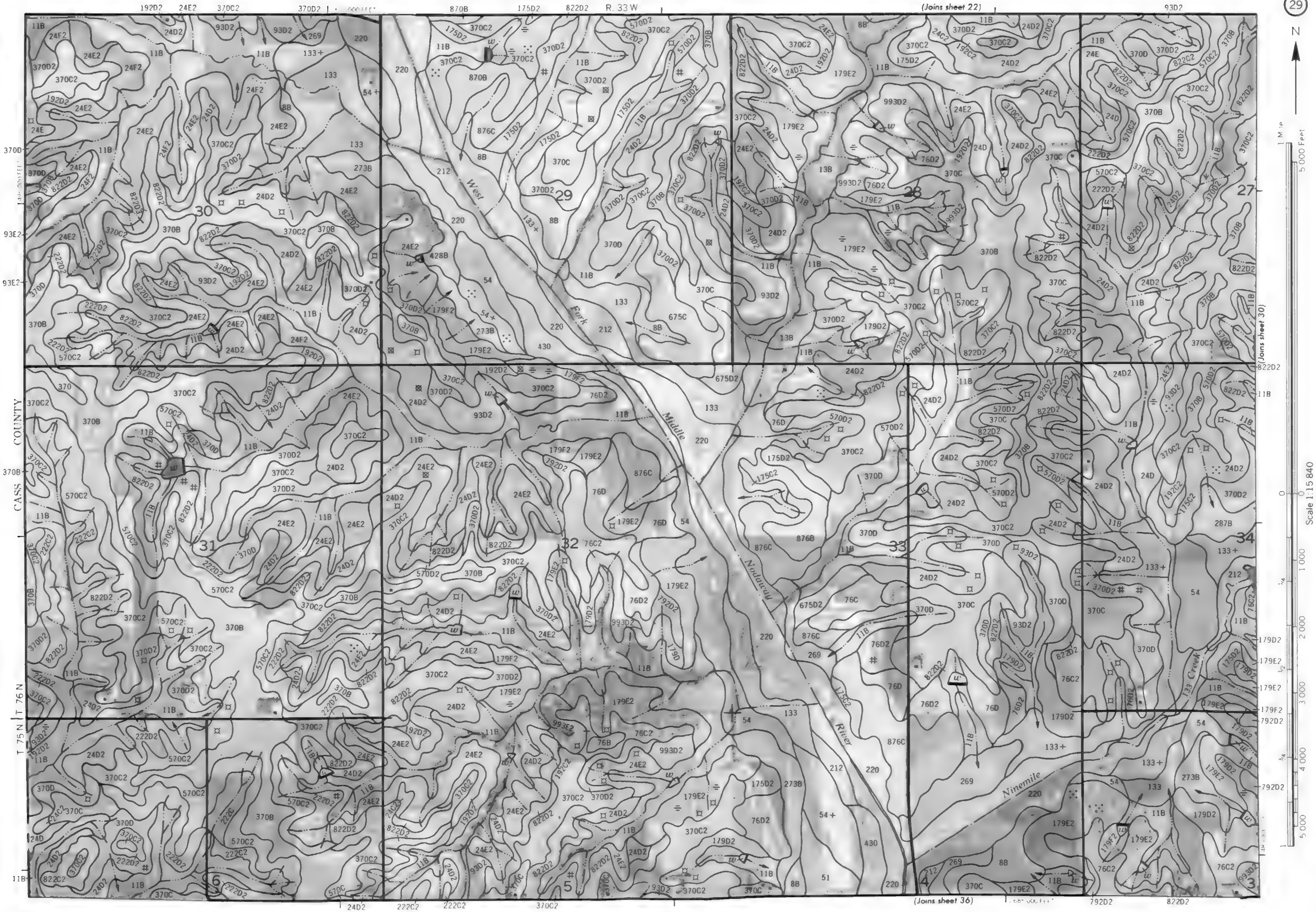



26
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 19)
R 31 W
(Joins sheet 25)
(Joins sheet 27)
T. 76 N
(Joins sheet 33)
9
10
11
12
13
14
15
16
21
22
23
24
Bruce
Branch
water


R 31 W | R 30 W
R 30 W
(Joins sheet 20)
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 34)
T 76 N
N
Branch
Bruce
MIDDLE
RIVER
MIDDLE
RIVER
water
water
7
8
9
12
13
16
17
18
19
20
21
24
1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
0
1/4
1/2
3/4
Scale 1:15 840

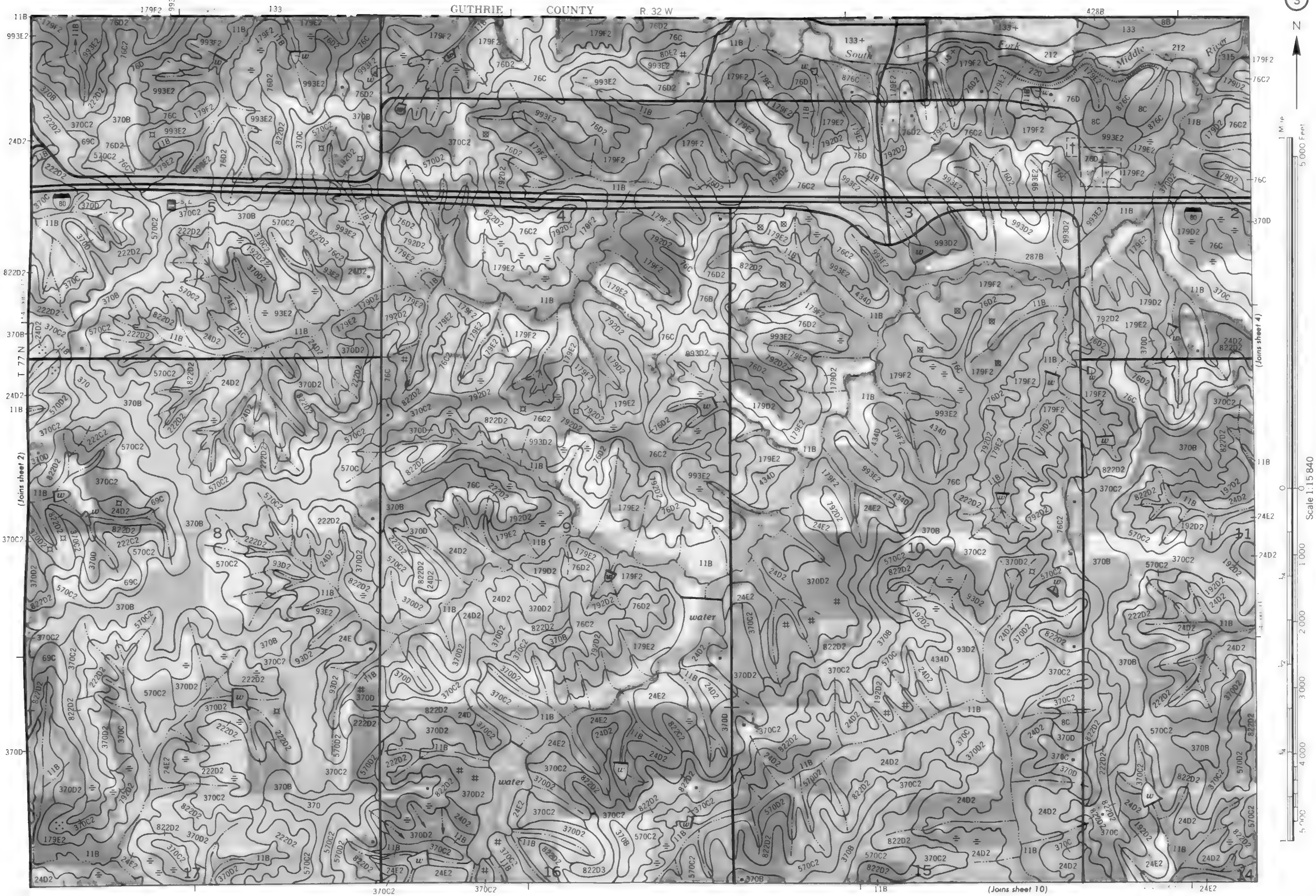
ADAIR COUNTY, IOWA — SHEET NUMBER 28

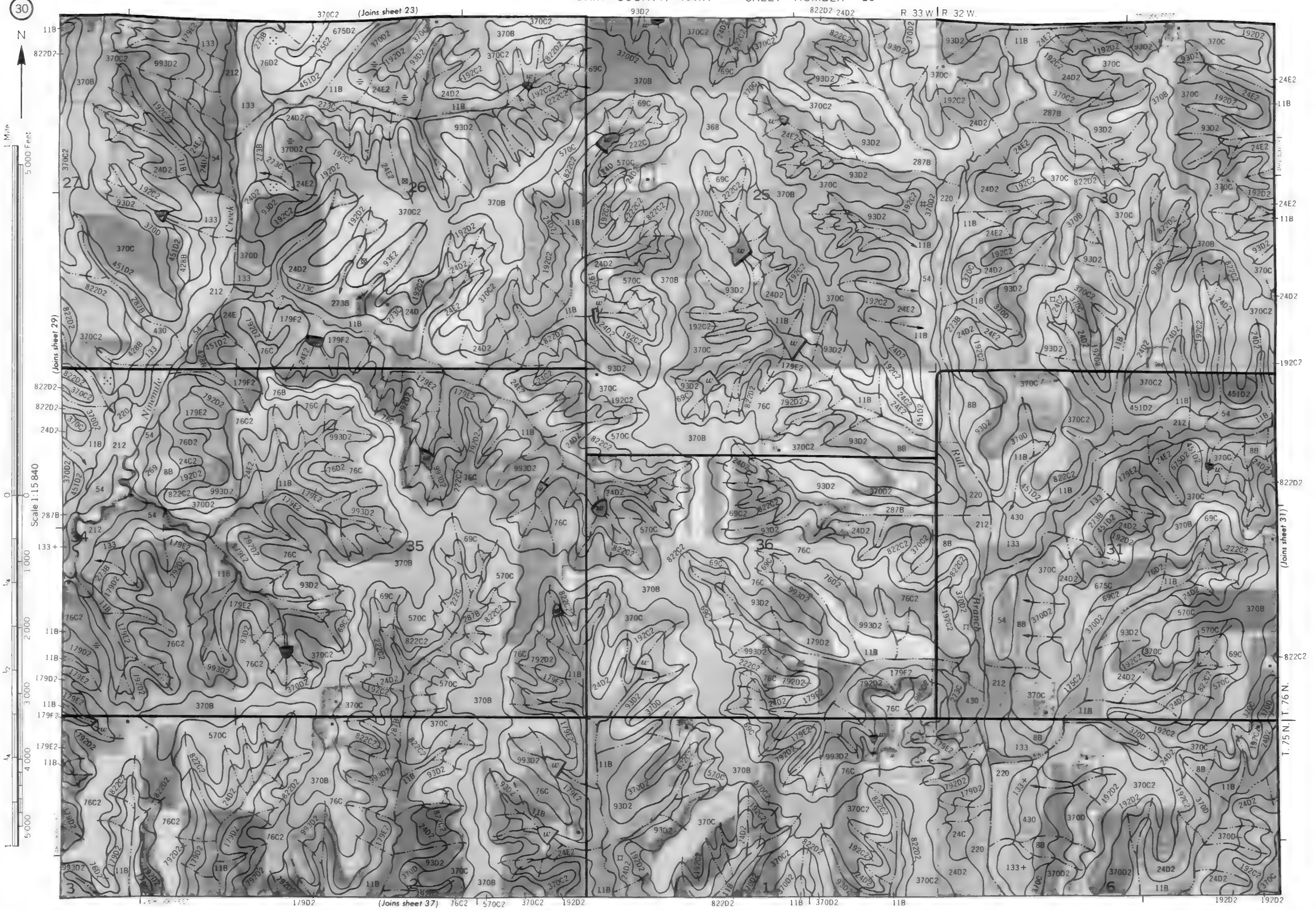


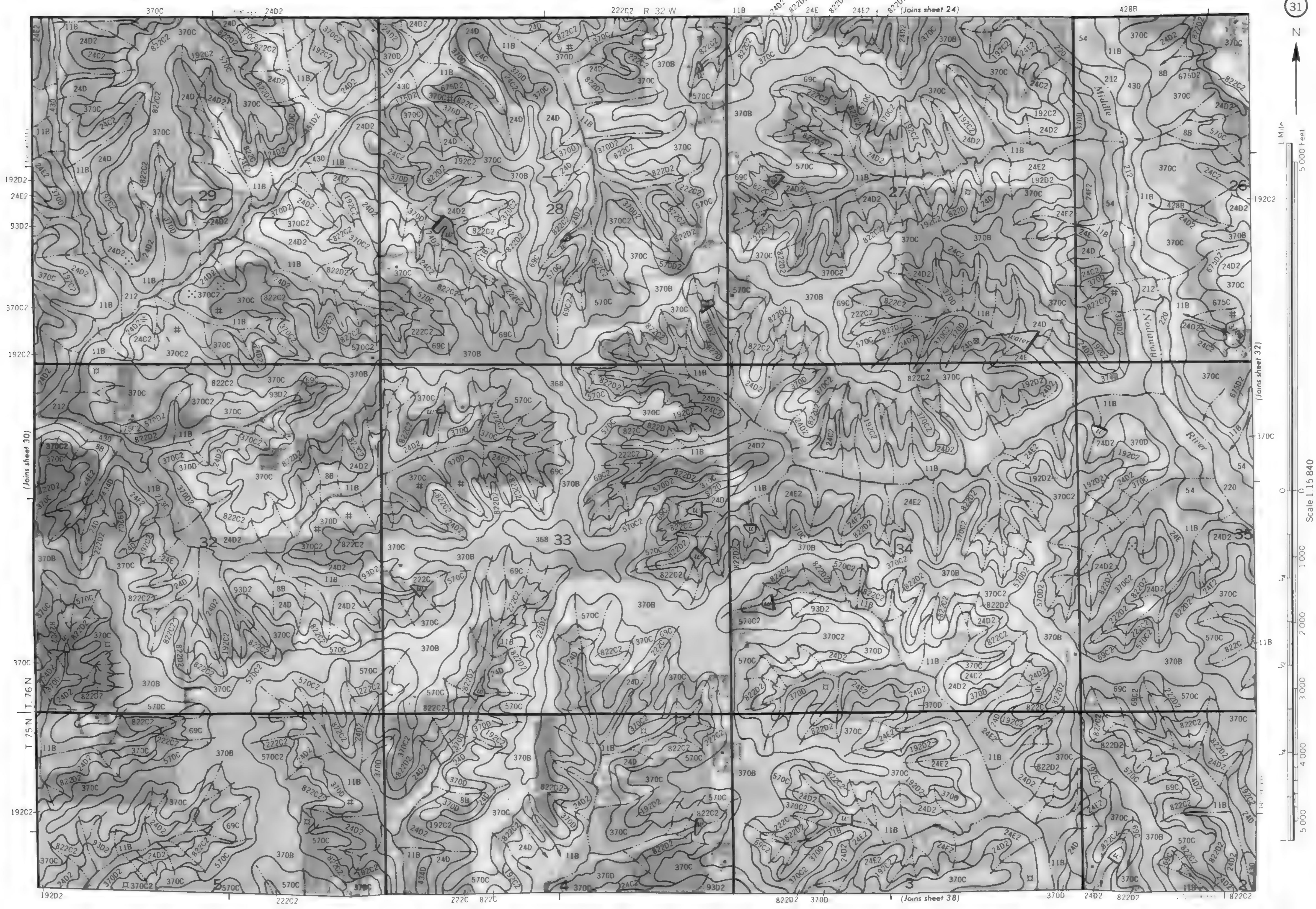

29
N
R. 33 W
(Joins sheet 22)
(Joins sheet 30)
(Joins sheet 36)
CASS COUNTY
T 76 N
T 75 N
West Fork
Middle Nodaway River
Ninemile
Creek
30
29
28
27
31
32
33
34
6
5
4
3
1 Mile
5 000 Feet
Scale 1:15 840

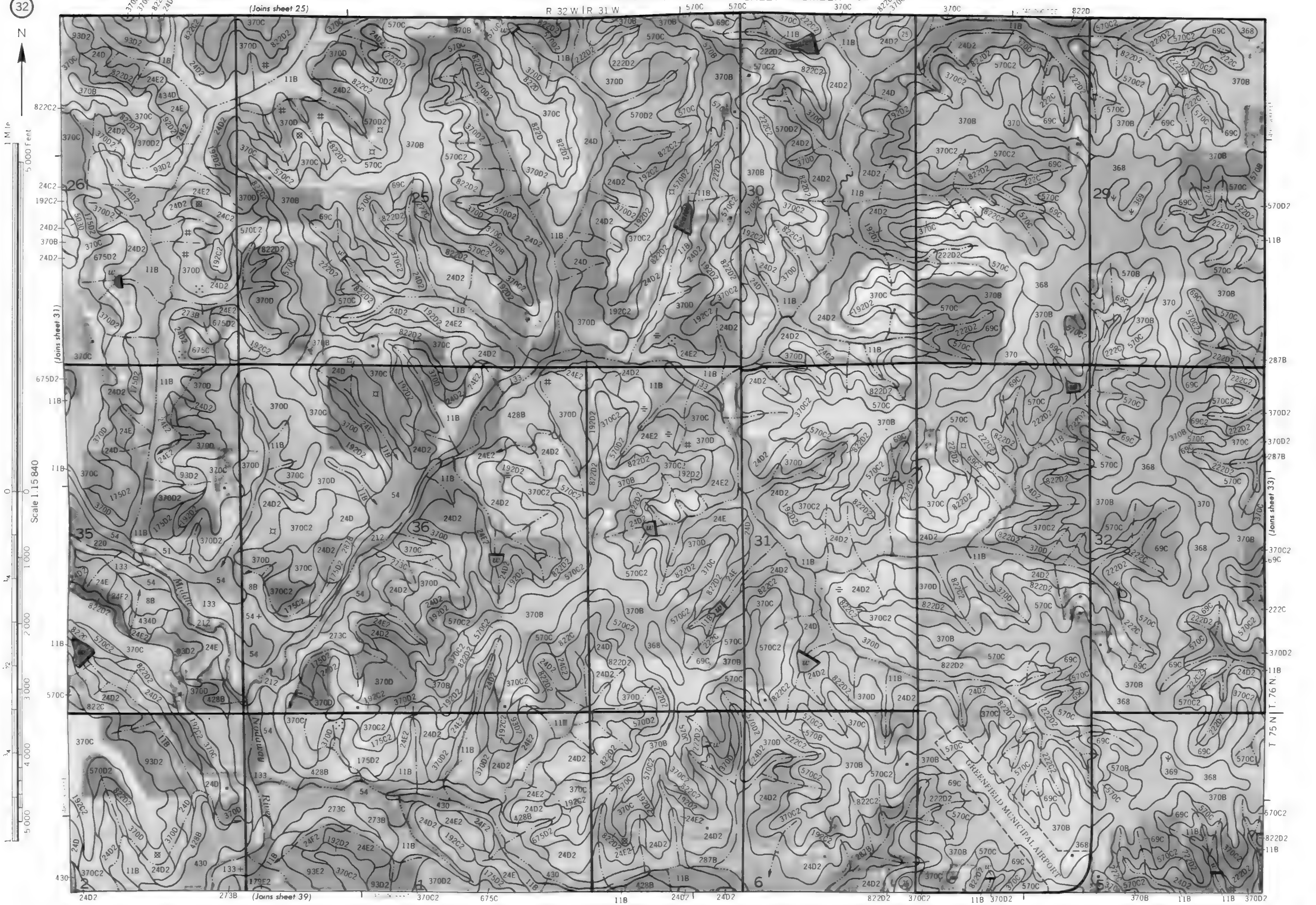
ADAIR COUNTY, IOWA — SHEET NUMBER 3

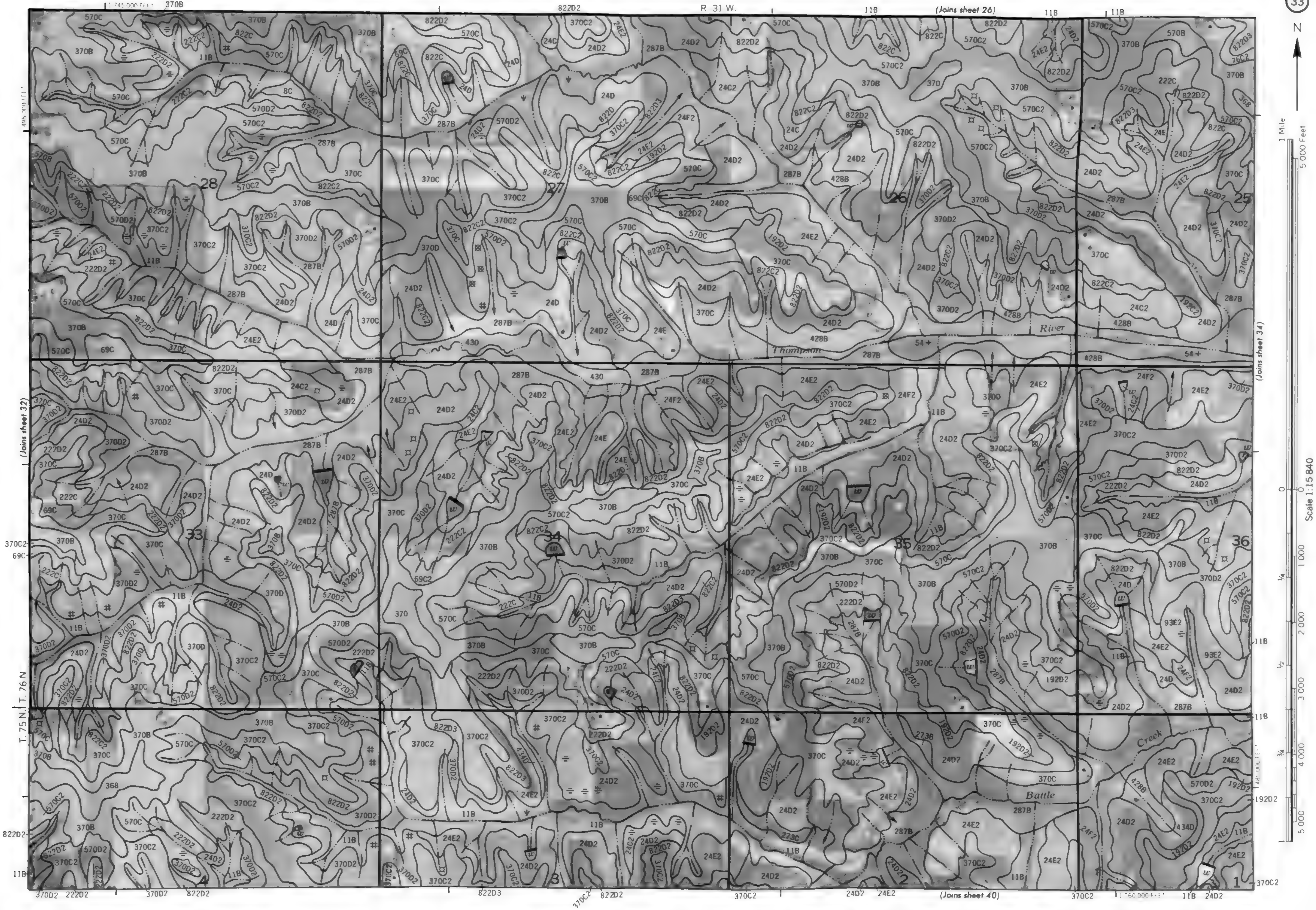
3

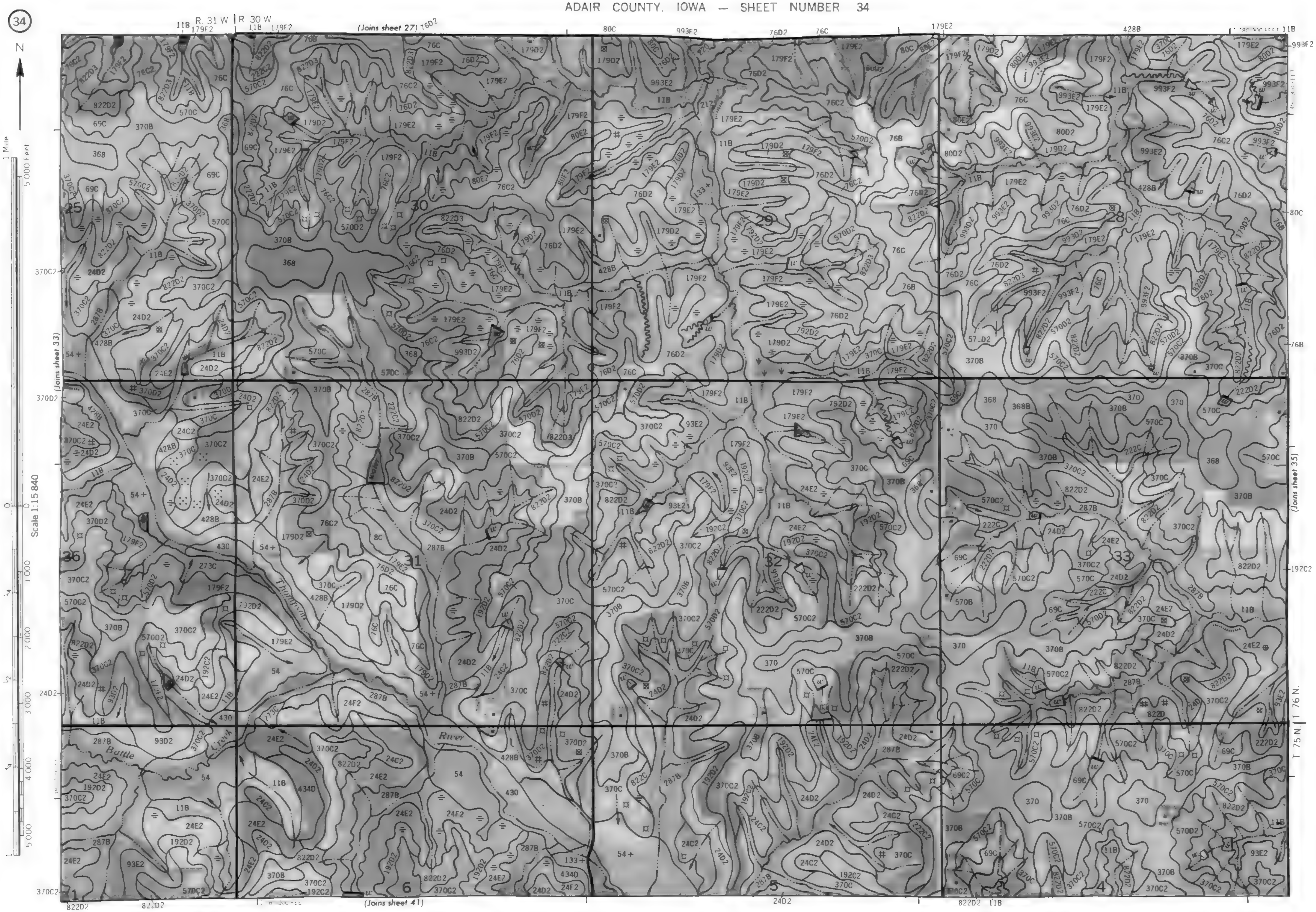


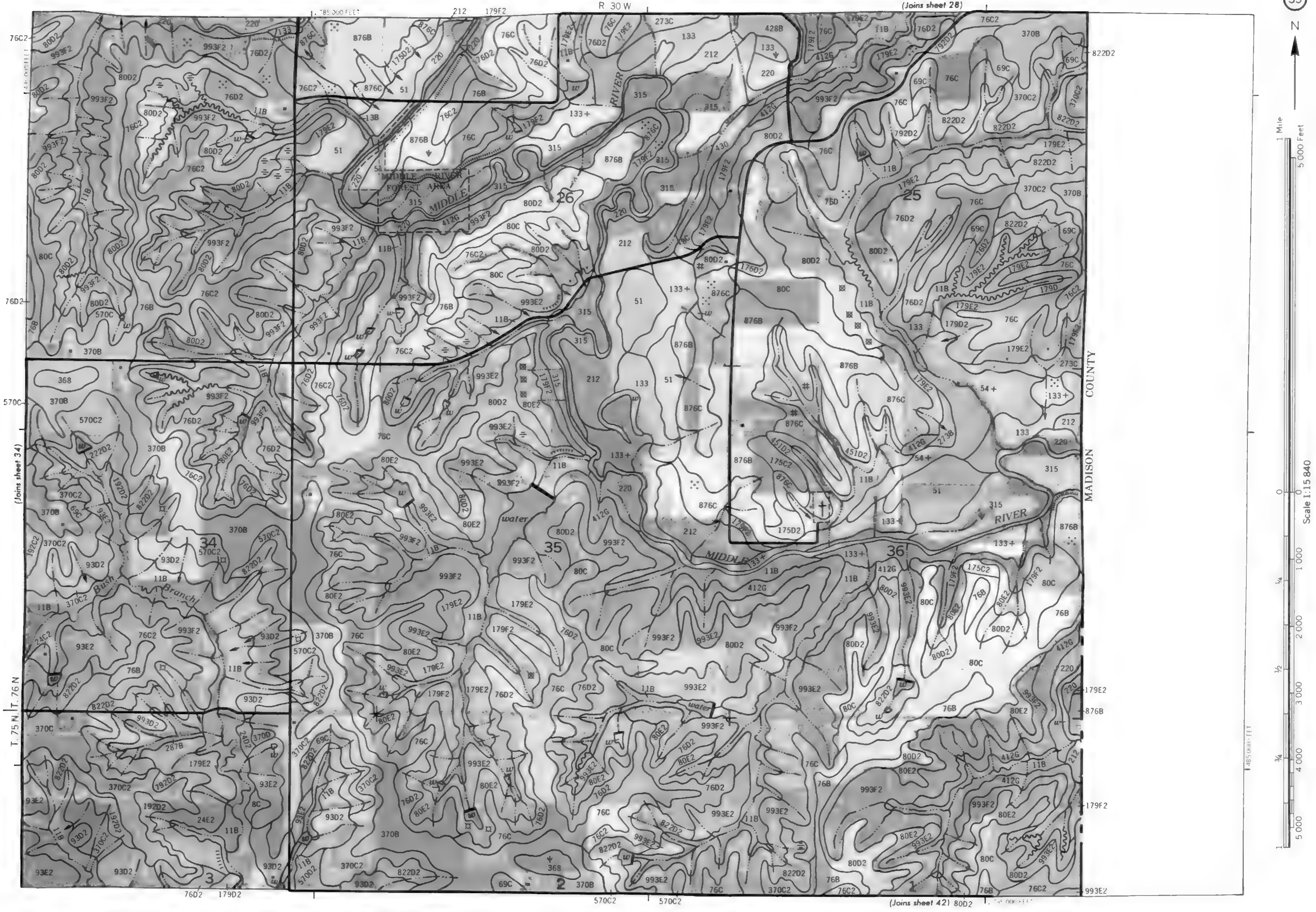

30
N
(Joins sheet 23)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 37)
R. 33 W. | R. 32 W.
T. 76 N.
T. 75 N.
Scale 1:15 840
1 Mile
5 000 Feet
27
26
25
30
35
36
31
3
2
1
6
Creek
Ninemile
Rull
Branch
370C2
675D2
370D2
192D2
93D2
370B
370C
11B
24E2
24D2
822D2
993D2
133
212
451D2
179F2
179E2
76C
76C2
570C
287B
8B
54
220
430


R 32 W
(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 38)
T. 76 N.
T. 75 N.
N
Middle
Nodaway
River
Water
1 Mile
5 000 Feet
Scale 1:15 840
29
28
27
26
32
33
34
35
5
4
3
2

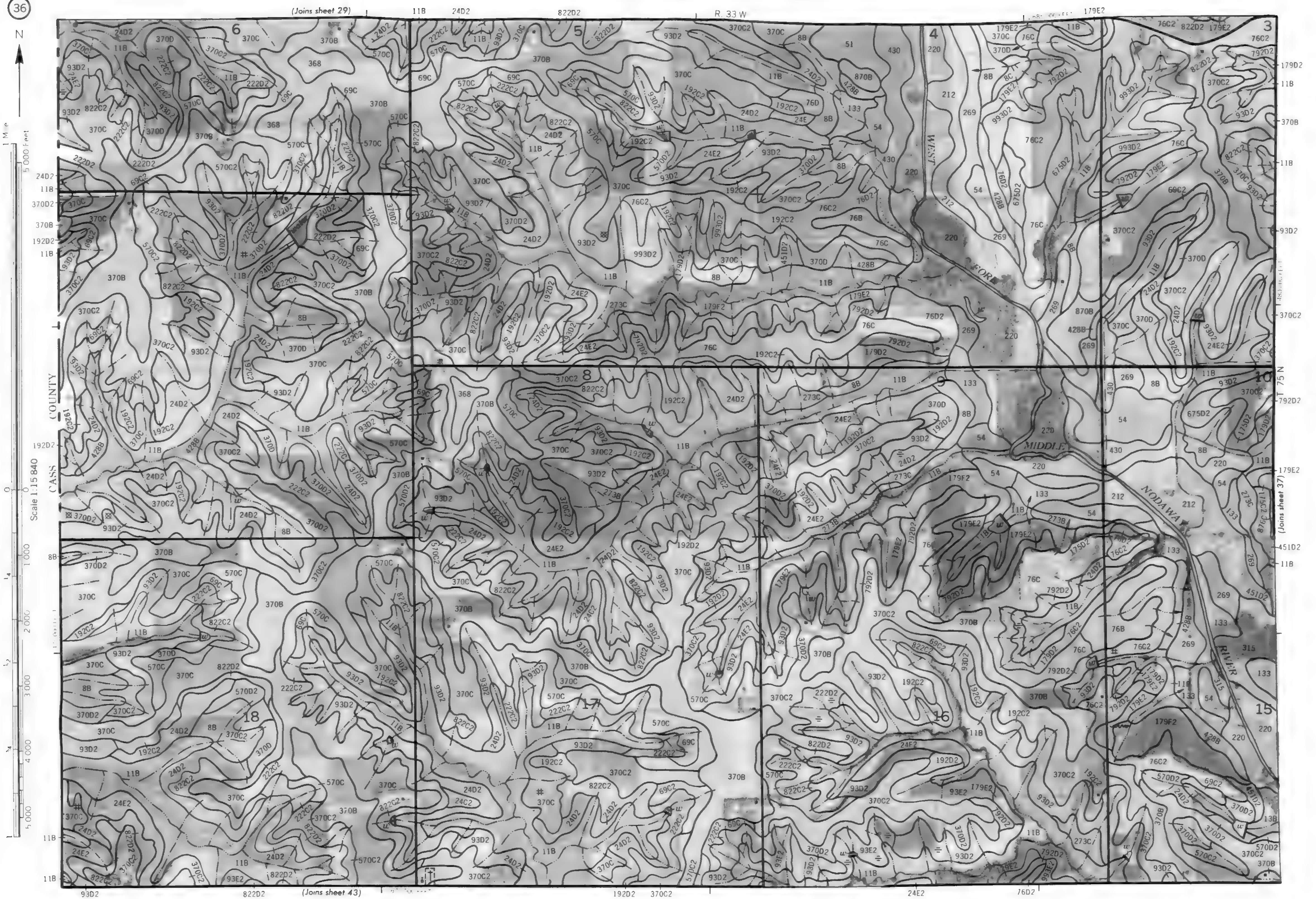

(Joins sheet 25)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 39)
R. 32 W. | R. 31 W.
T. 76 N. | T. 75 N.
N
1 Mile
5 000 Feet
Scale 1:15 840
GREENFIELD MUNICIPAL AIRPORT
Middle
Nodaway
River

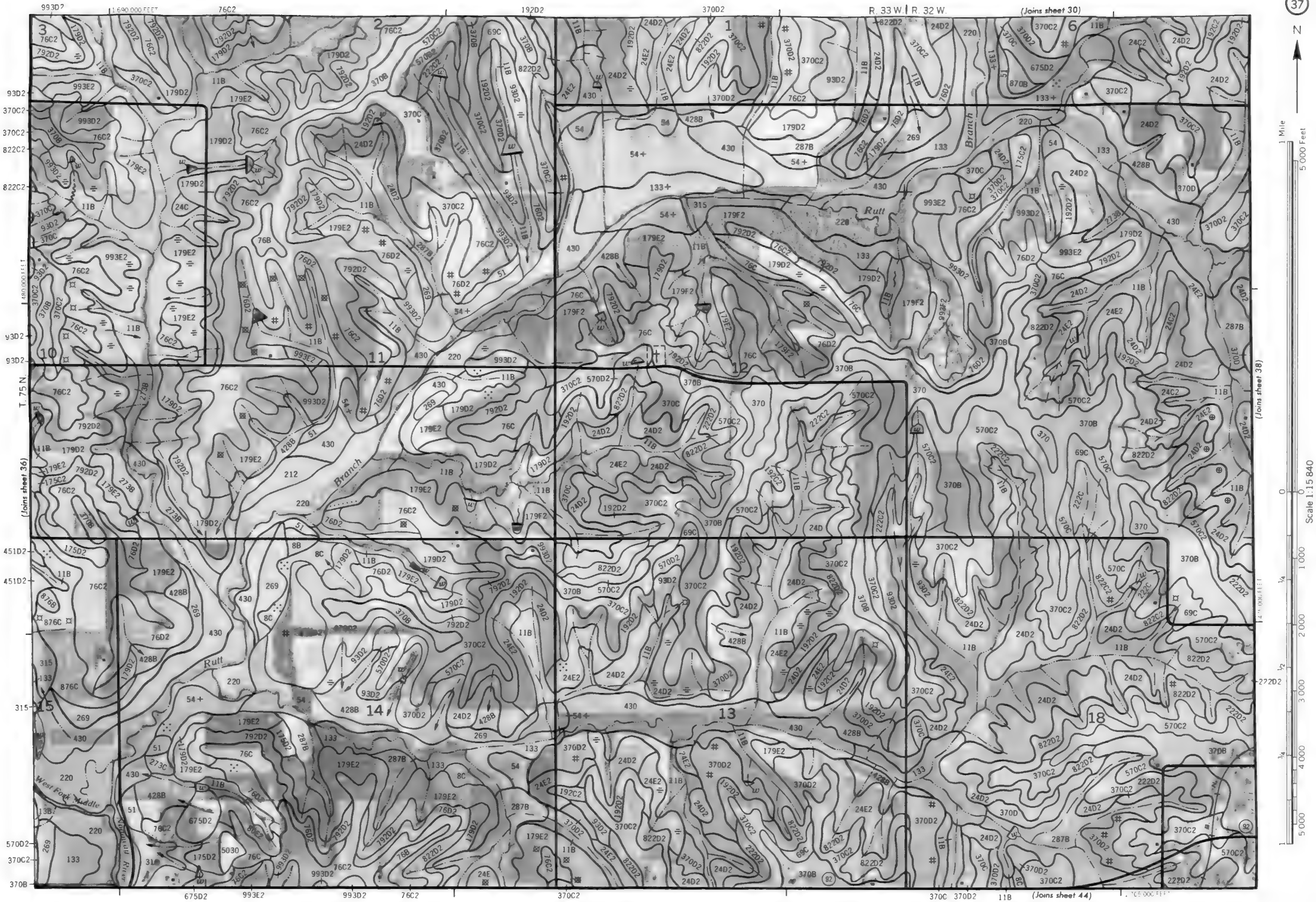

R. 31 W.
(Joins sheet 26)
(Joins sheet 34)
(Joins sheet 40)
(Joins sheet 32)
T. 76 N.
T. 75 N.
N
Thompson
River
Battle
Creek
28
27
26
25
33
34
35
36
4
3
2
1
1 Mile
5 000 Feet
Scale 1:15 840

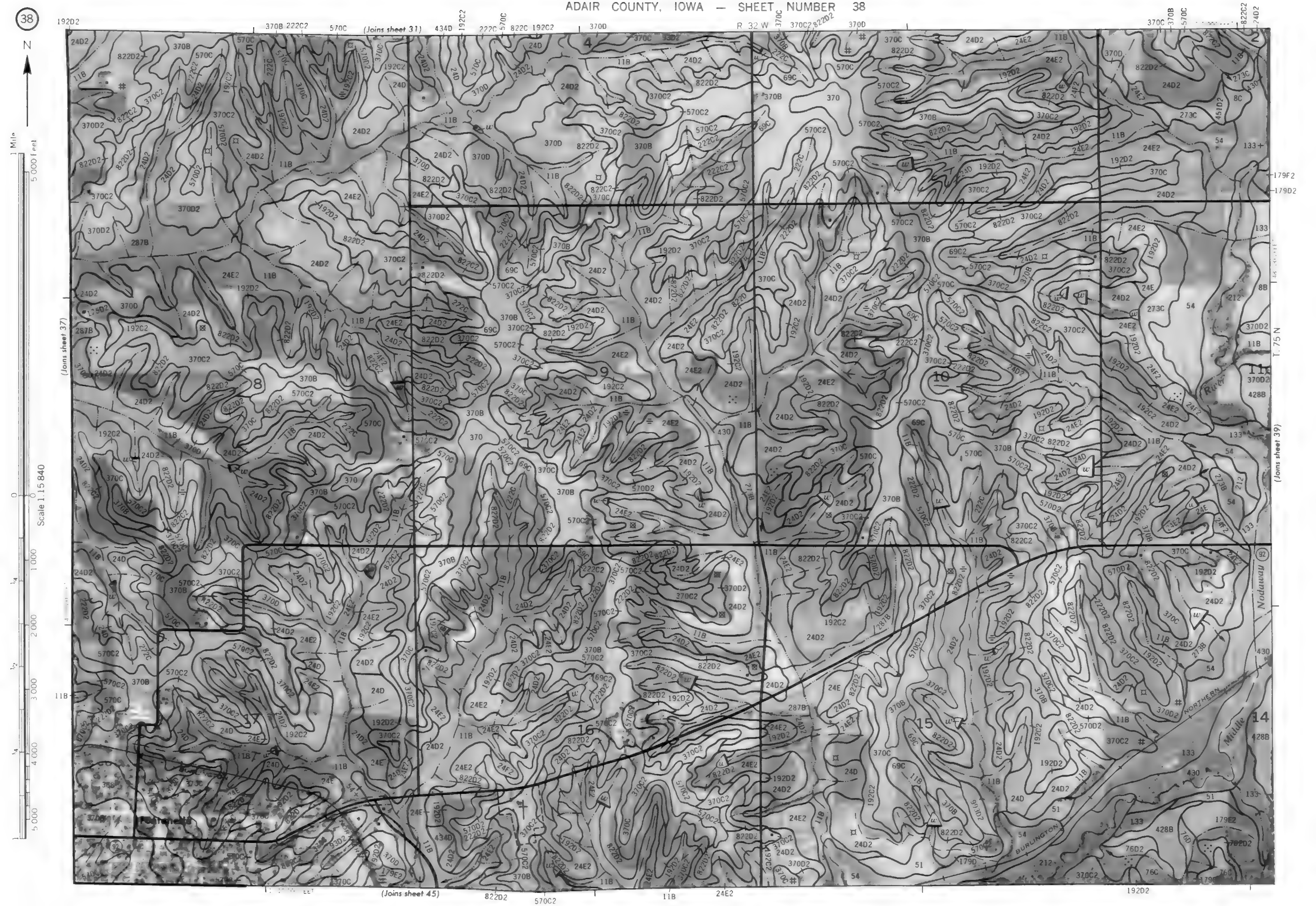

34
N
R. 31 W
R. 30 W
(Joins sheet 27)
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 41)
T 76 N.
T 75 N.
Scale 1:15 840
1 Mile
5 000 Feet
Thompson
River
Battle
Creek
25
30
29
28
36
31
32
33
1
6
5
4

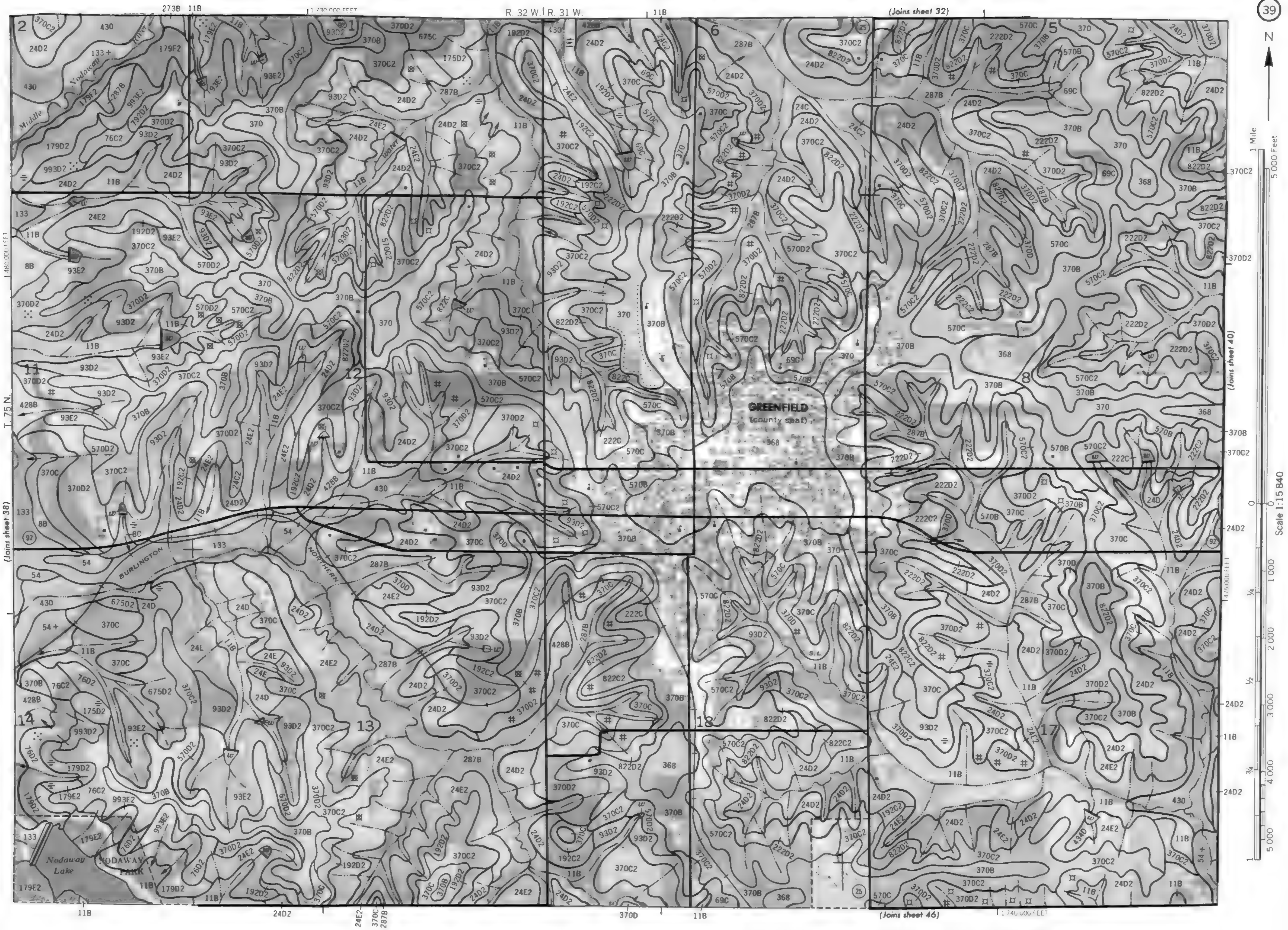


35
N
R 30 W
(Joins sheet 28)
(Joins sheet 34)
(Joins sheet 42)
T. 76 N
T. 75 N
MADISON COUNTY
MIDDLE RIVER
MIDDLE RIVER FOREST AREA
Bush Branch
water
26
25
34
35
36
3
2
1
1 Mile
5 000 Feet
Scale 1:15 840

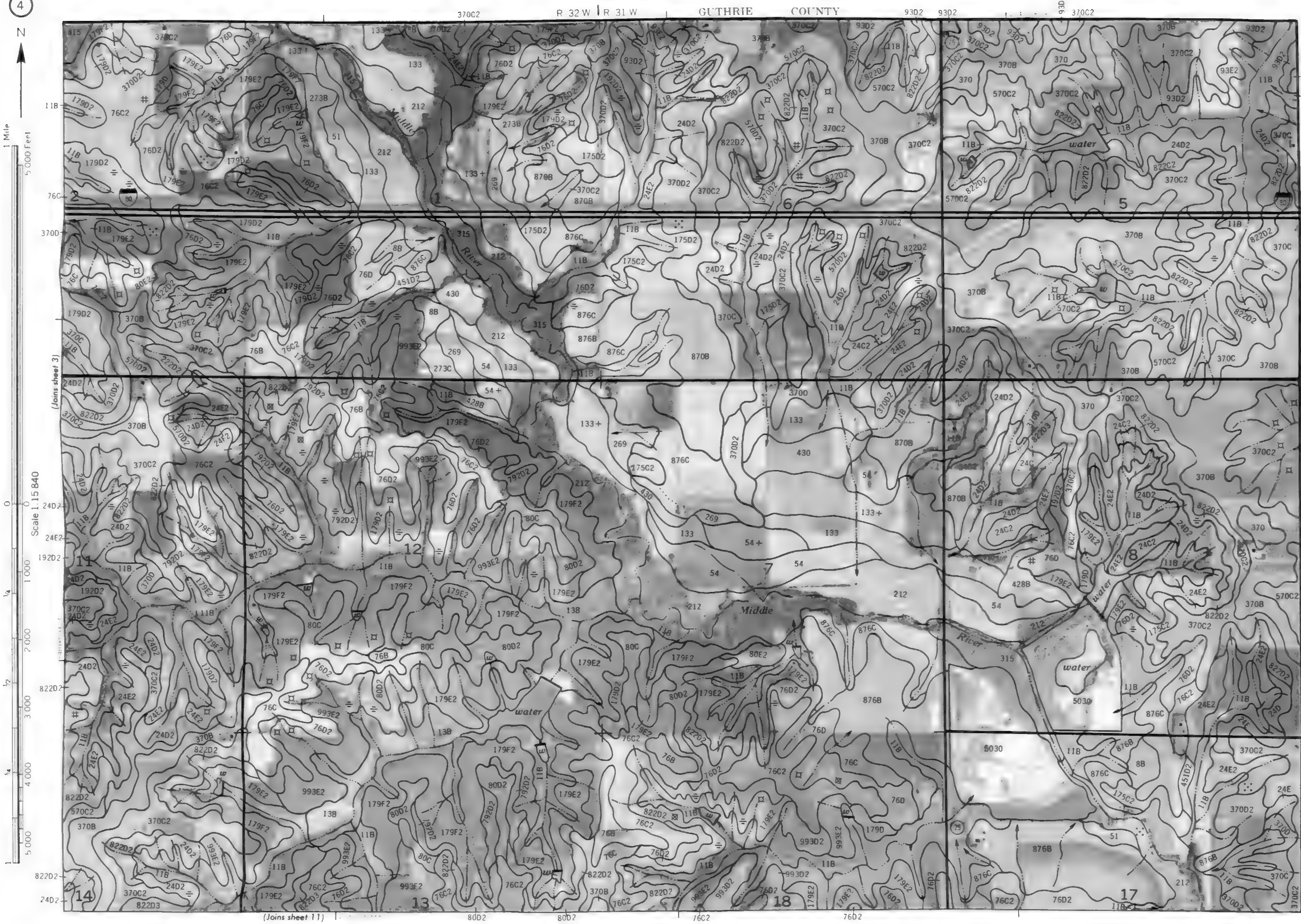

36
N
(Joins sheet 29)
R. 33 W
T. 75 N
(Joins sheet 37)
(Joins sheet 43)
CASS COUNTY
WEST FORK
MIDDLE
NODAWA RIVER
Scale 1:15 840
1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000

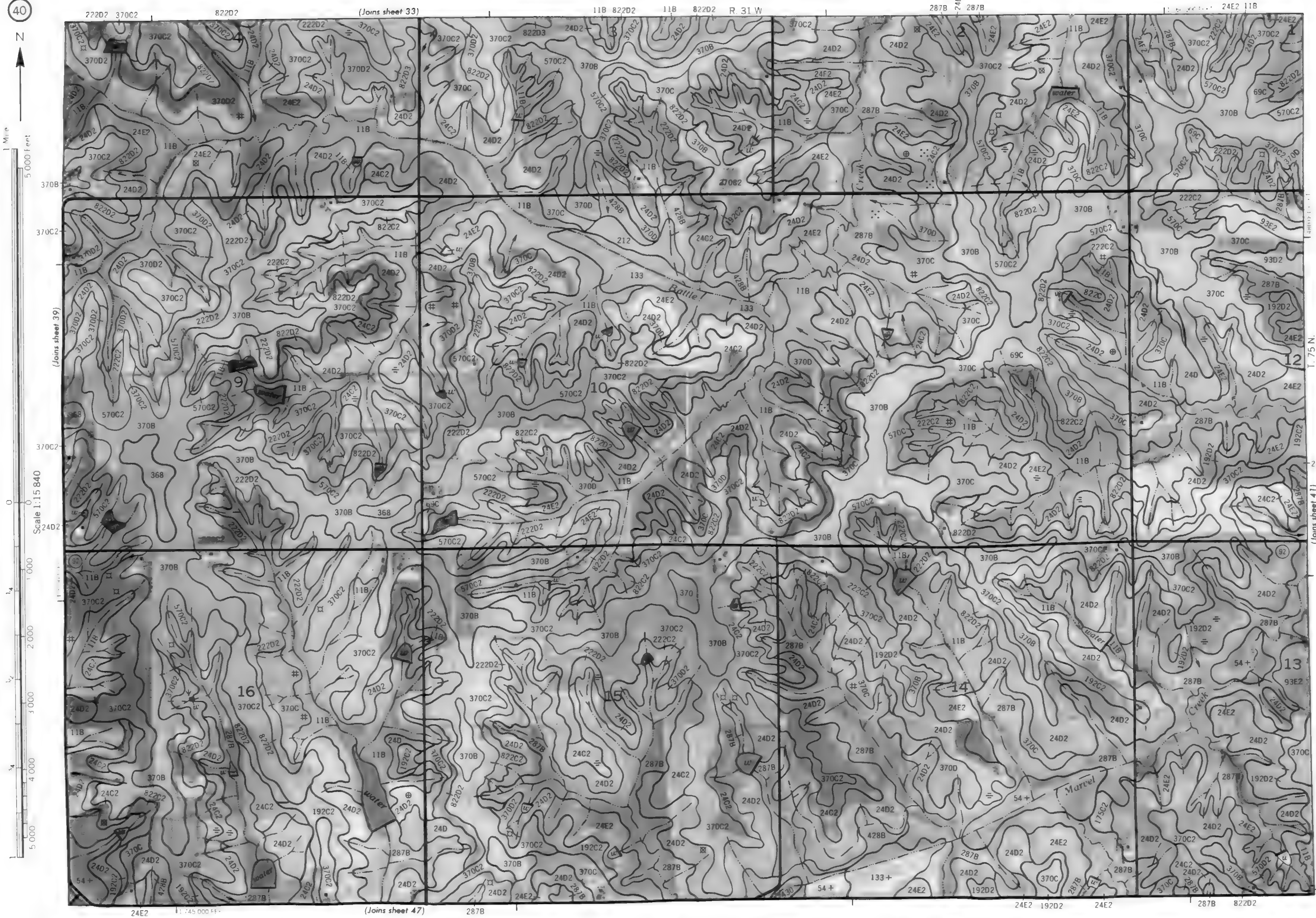

37
(Joins sheet 30)
(Joins sheet 38)
(Joins sheet 44)
(Joins sheet 36)
R. 33 W.
R. 32 W.
T. 75 N.
1 690 000 FEET
480 000 FEET
N
1 Mile
5 000 Feet
Scale 1:15 840
Rutt
Branch
West Fork Middle Nodaway River
1
2
3
6
10
11
12
13
14
15
18

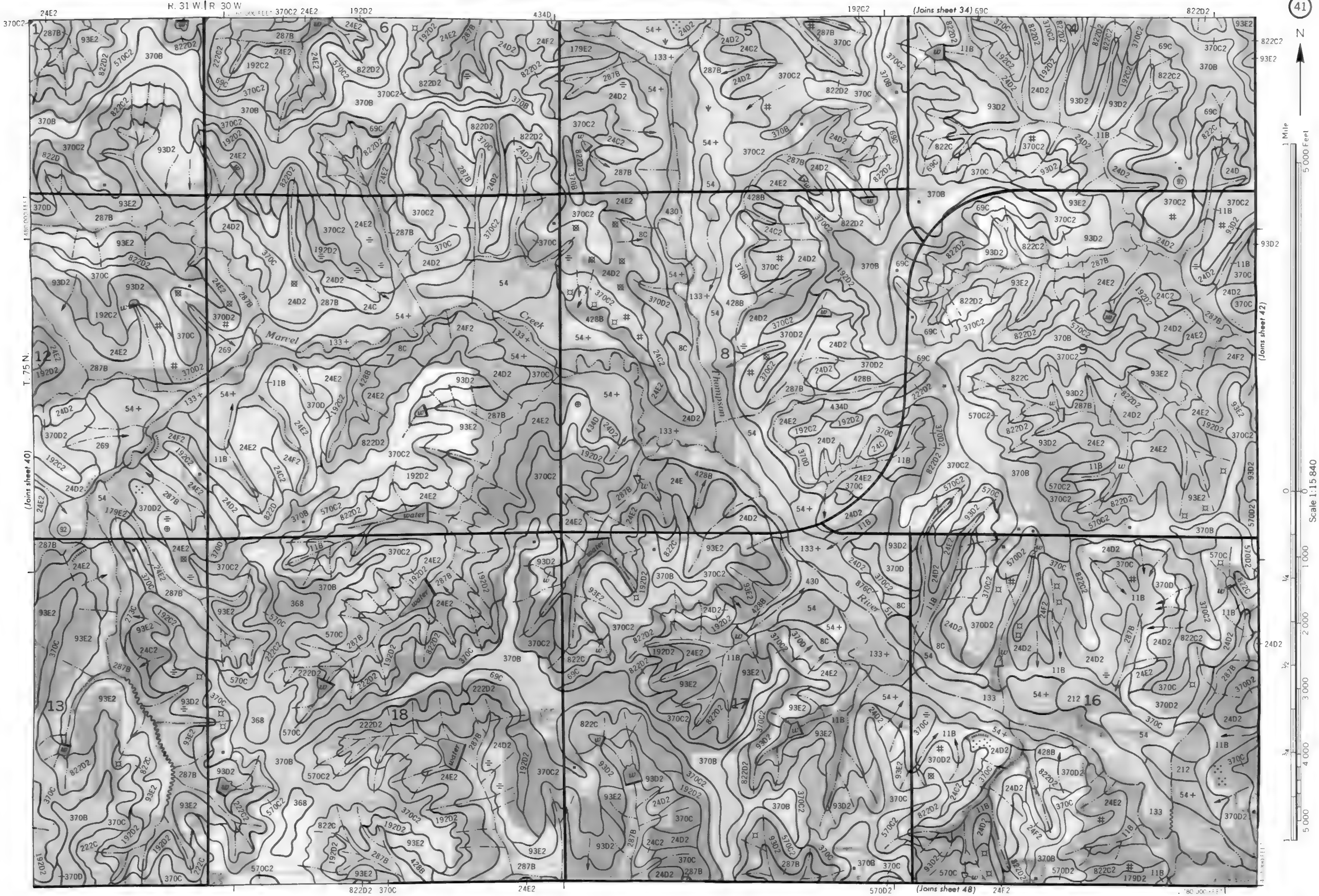

38
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 31)
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 45)
R. 32 W.
T. 75 N.
Nodaway
Middle
NORTHERN
BURLINGTON


39
N
R. 32 W. | R. 31 W.
T. 75 N.
(Joins sheet 32)
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 46)
GREENFIELD
(county seat)
Nodaway Lake
NODAWAY PARK
Middle Nodaway River
BURLINGTON NORTHERN
1 730 000 FEET
1 740 000 FEET
480 000 FEET
475 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

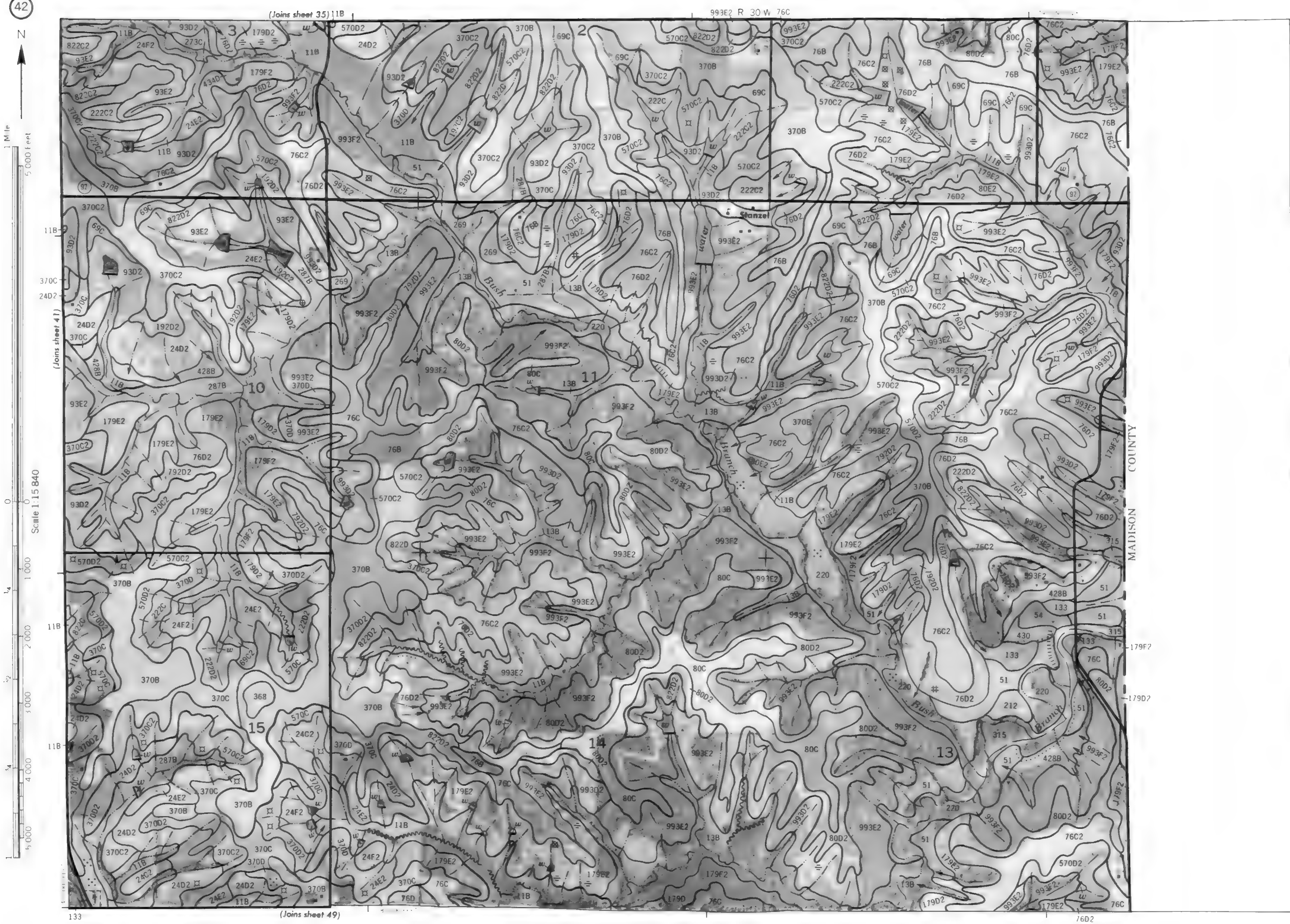
ADAIR COUNTY, IOWA — SHEET NUMBER 4

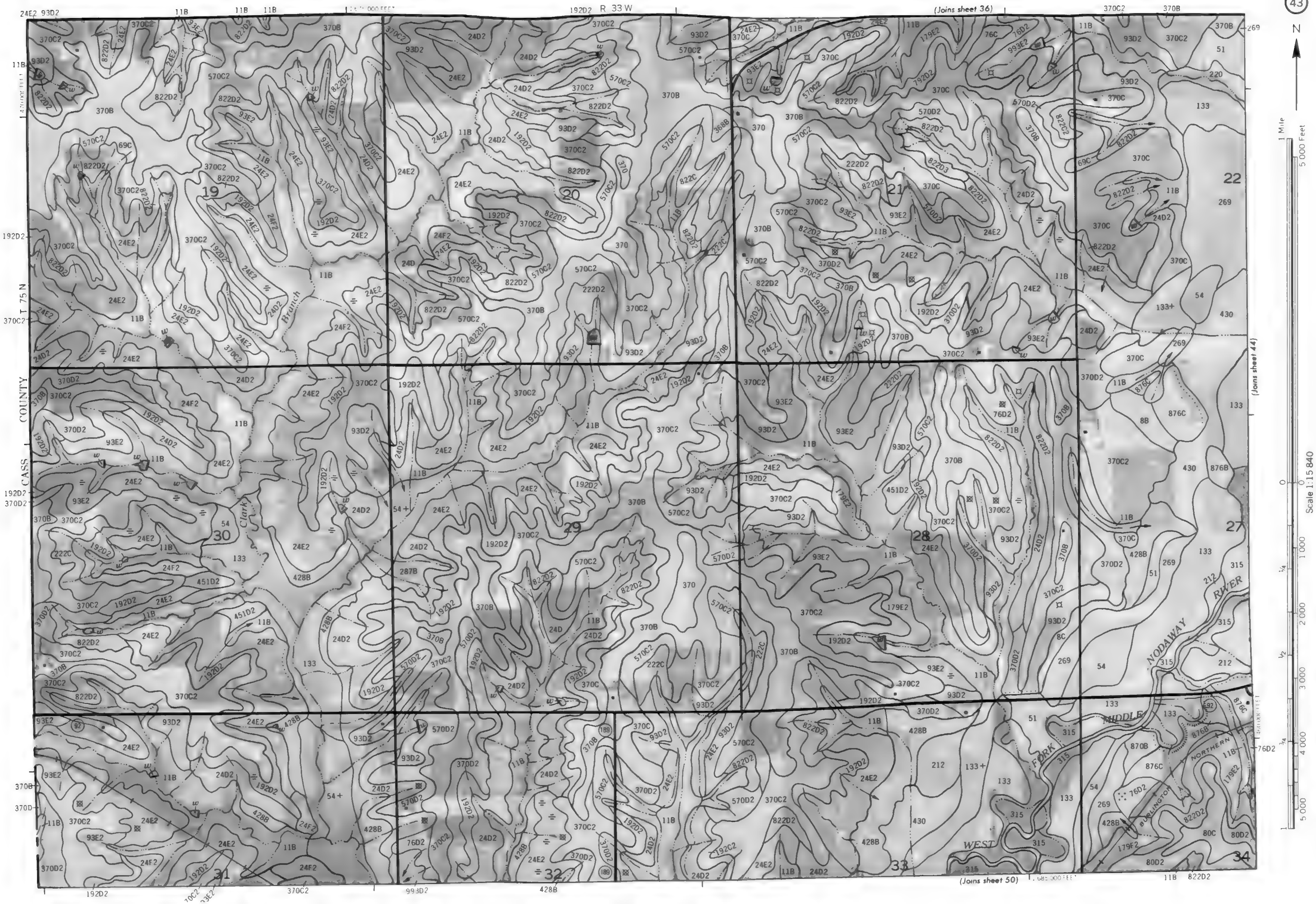



(Joins sheet 33)
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 47)
R. 31 W.
T. 75 N.
N
Scale 1:15 840
1 Mile
5 000 Feet
Battle
Creek
Marvel
Creek
water

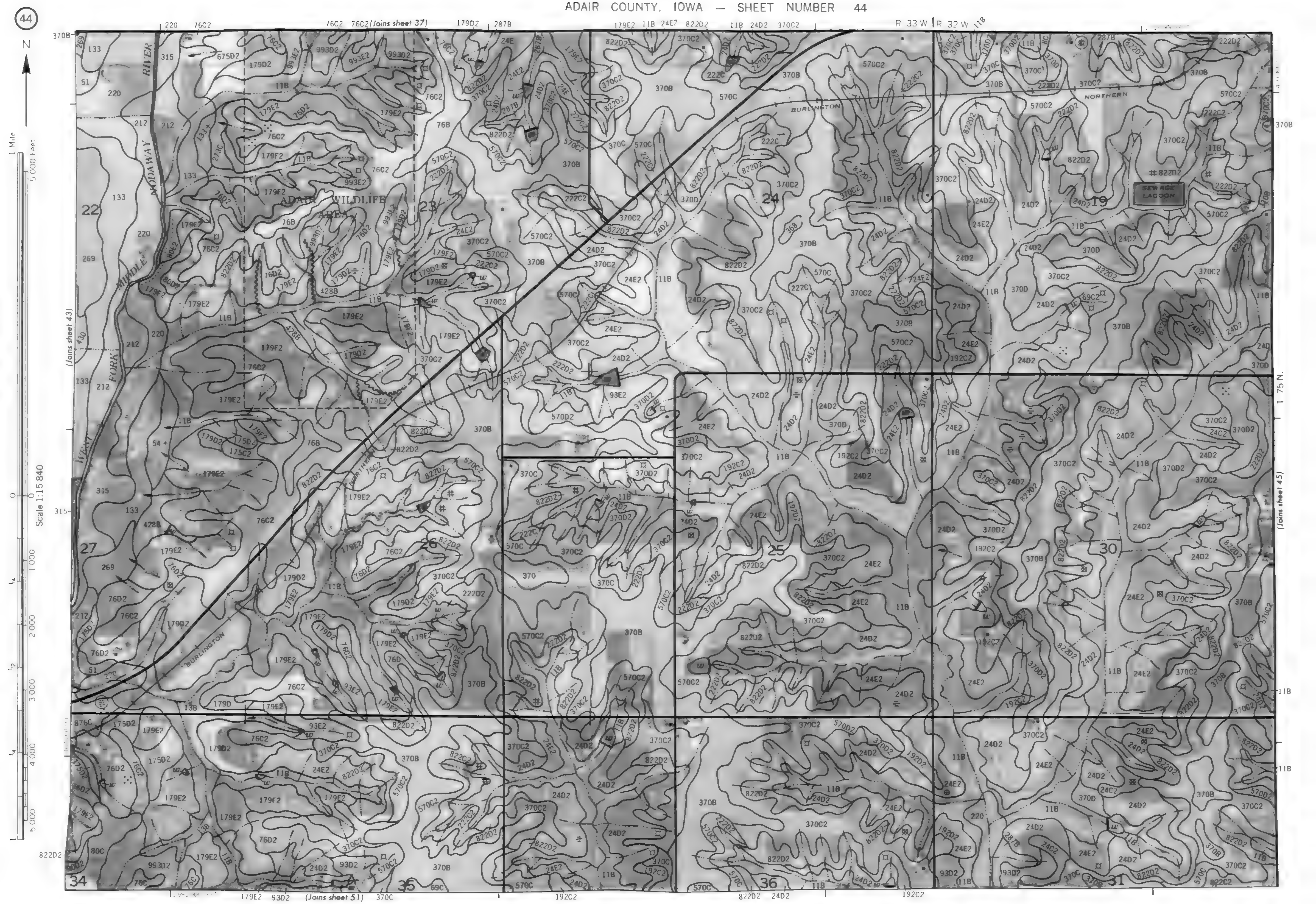

41
R. 31 W. | R. 30 W.
T. 75 N.
(Joins sheet 34)
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 48)
N
1 Mile
5 000 Feet
Scale 1:15 840
Marvel Creek
Thompson River
water
1
5
6
7
8
9
12
13
16
17
18

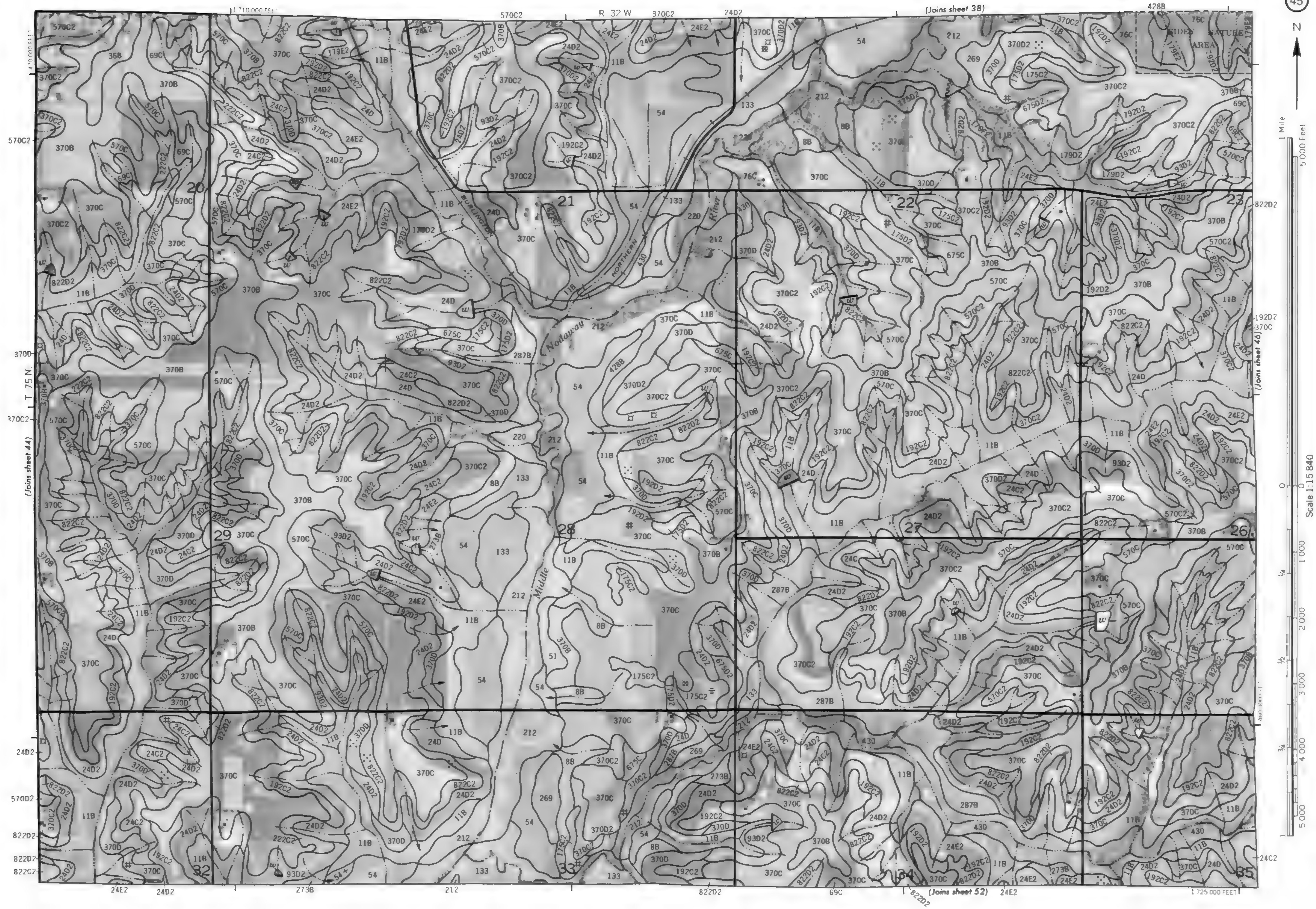
ADAIR COUNTY, IOWA — SHEET NUMBER 42



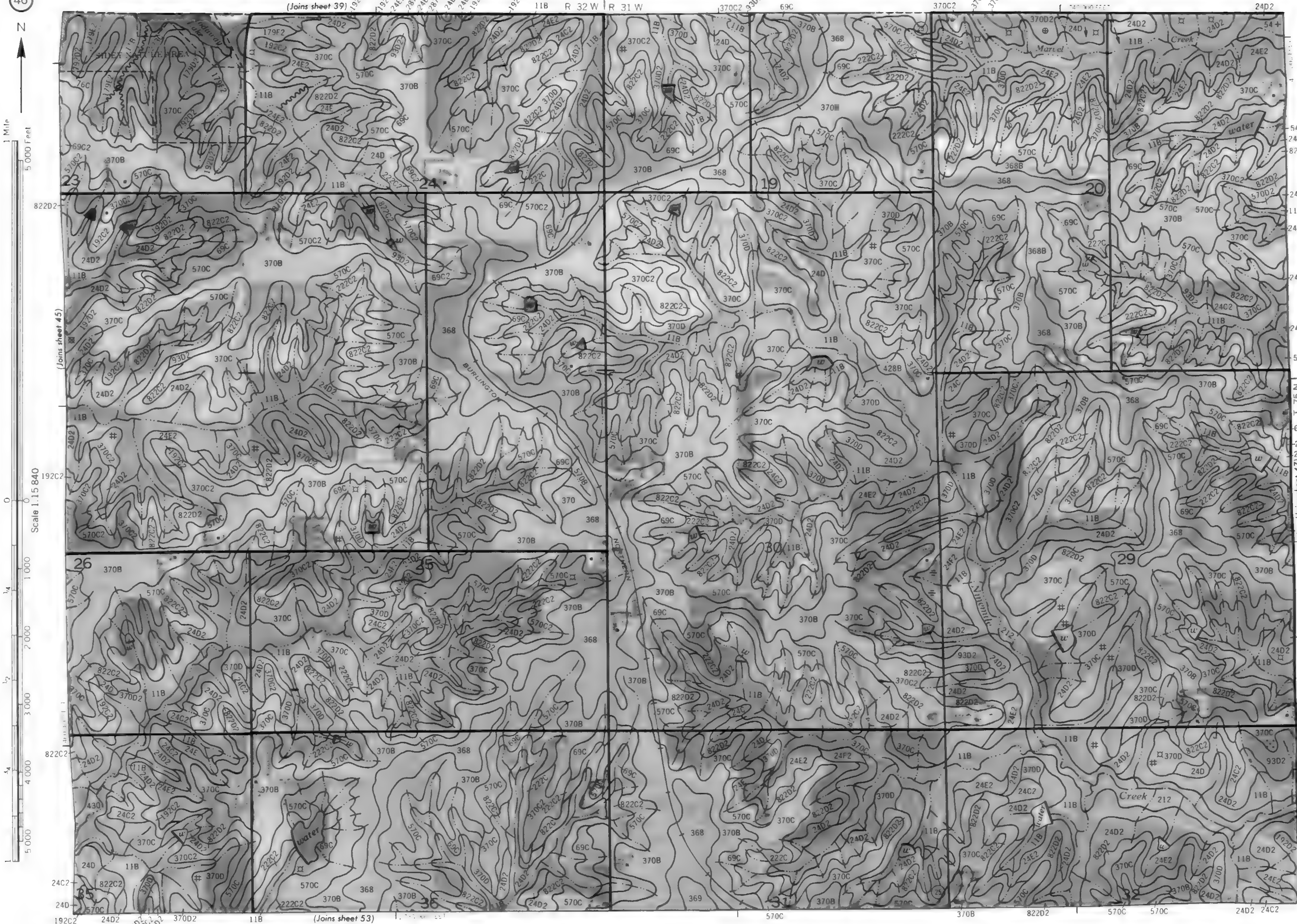


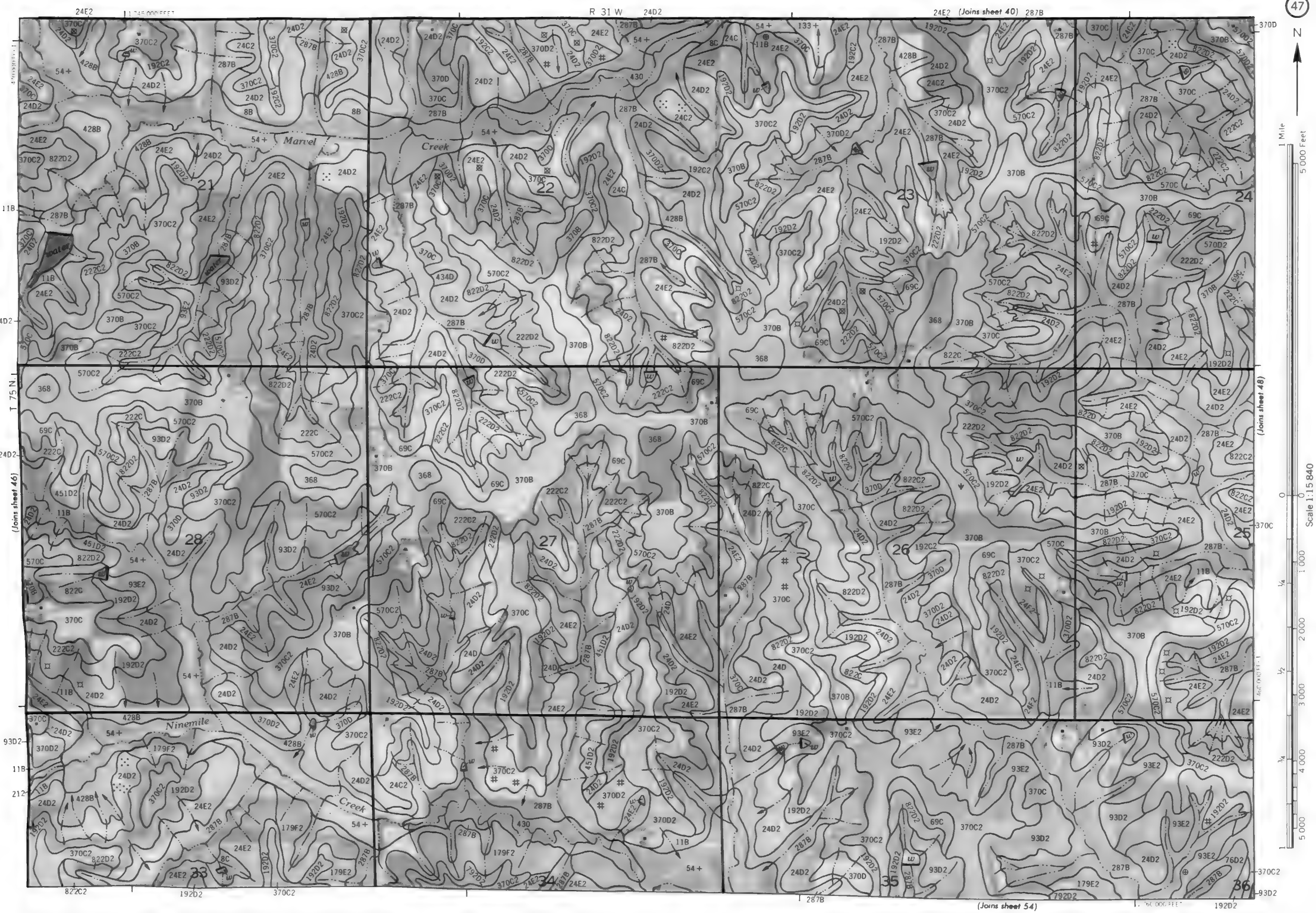
R 33 W
(Joins sheet 36)
(Joins sheet 44)
(Joins sheet 50)
T 75 N
CASS COUNTY
N
1 Mile
5 000 Feet
Scale 1:15 840
Clark Branch
NODAWAY RIVER
MIDDLE FORK
WEST
BURLINGTON NORTHERN
19
20
21
22
27
28
29
30
31
32
33
34

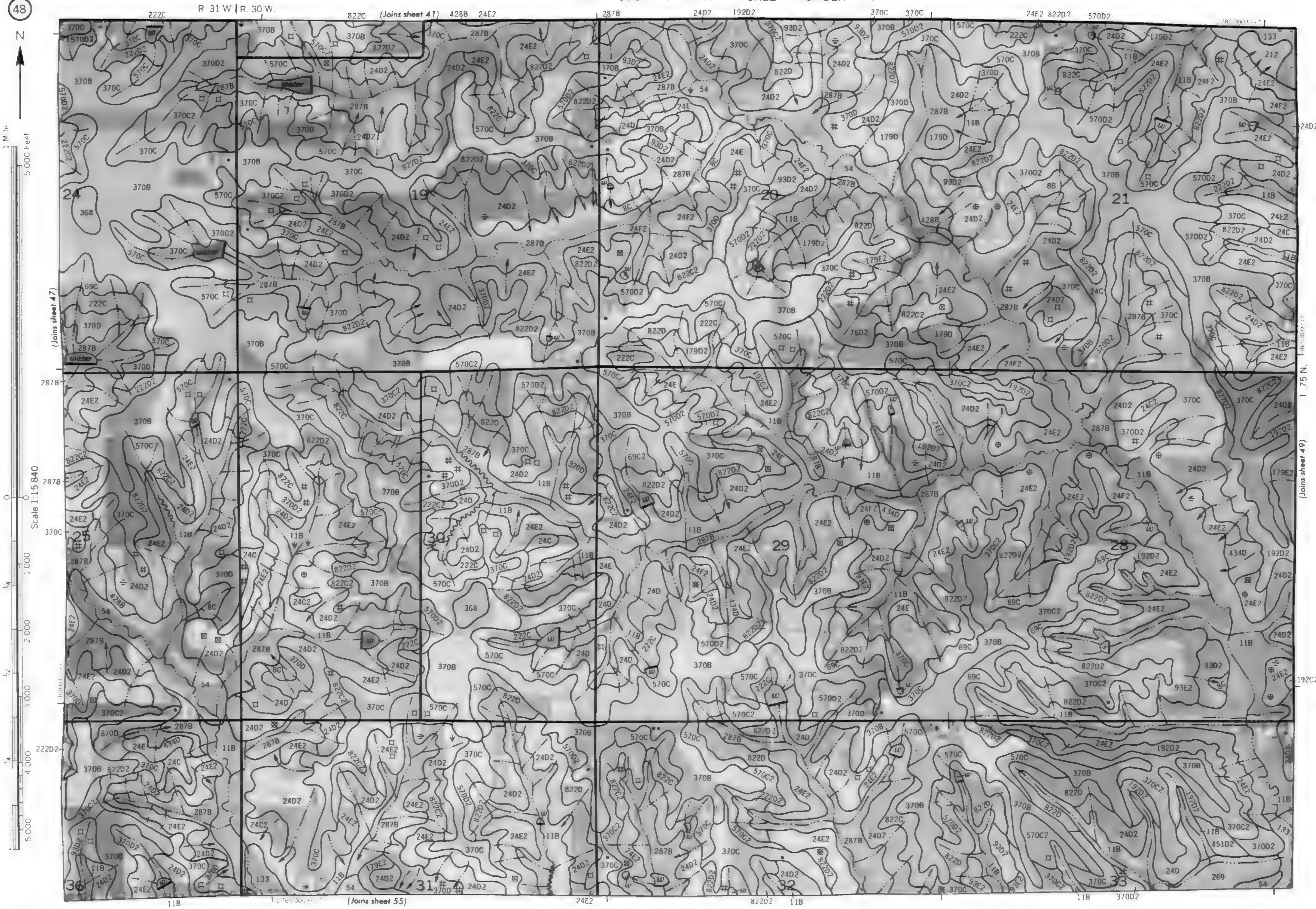

44
N
(Joins sheet 37)
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 51)
R 33 W
R 32 W
T 75 N.
ADAIR WILDLIFE AREA
NODAWAY RIVER
MIDDLE FORK
WEST
BURLINGTON
NORTHERN
SEWAGE LAGOON
22
23
24
19
27
26
25
30
34
35
36
31
1 Mile
5 000 Feet
Scale 1:15 840

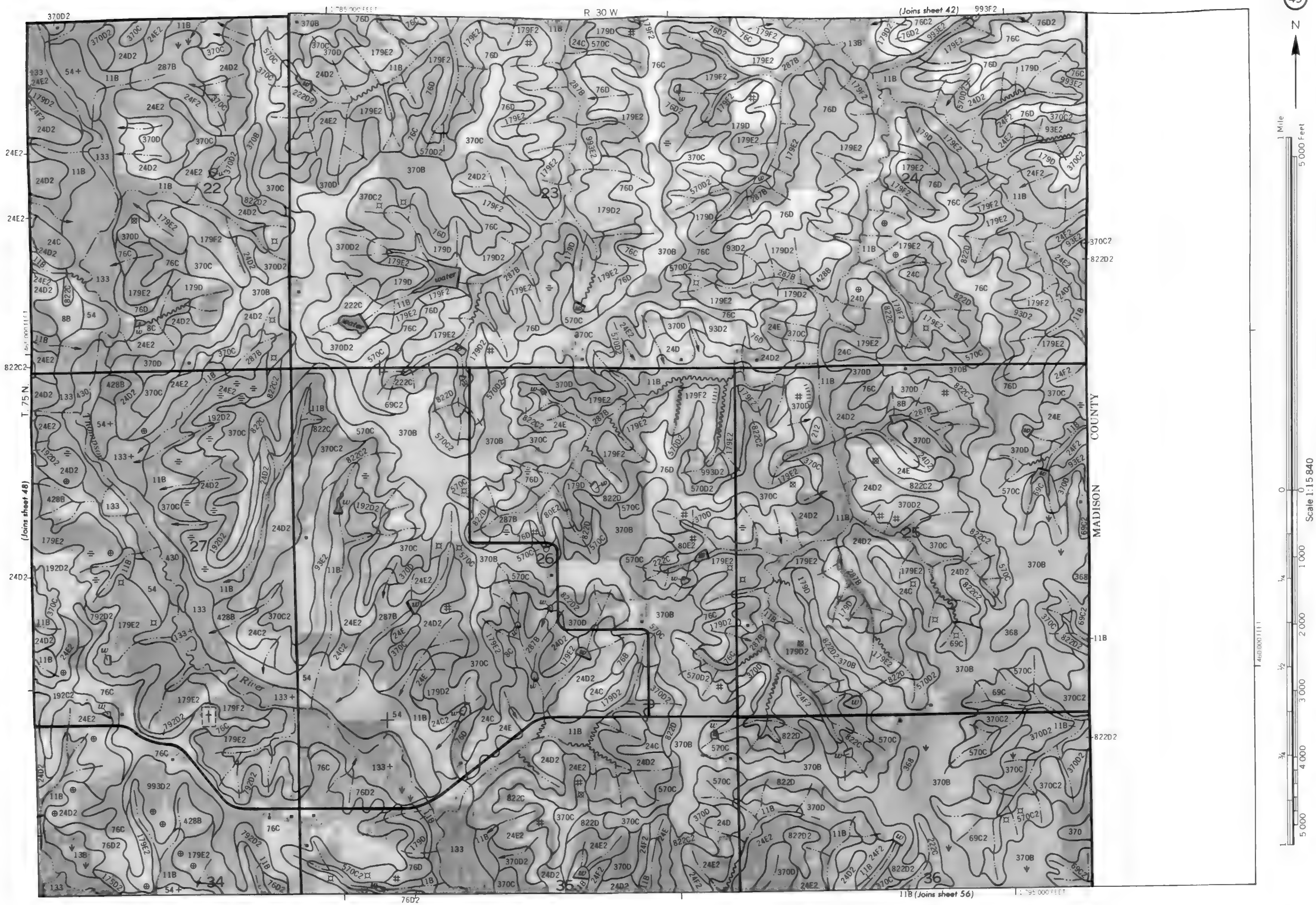

(Joins sheet 38)
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 52)
R. 32 W.
T. 75 N.
1 710 000 FEET
1 725 000 FEET
SIDEY NATURE AREA
Nodaway
Middle
River
BURLINGTON
NORTHERN
N
Scale 1:15 840
1 Mile
5 000 Feet

ADAIR COUNTY, IOWA — SHEET NUMBER 46

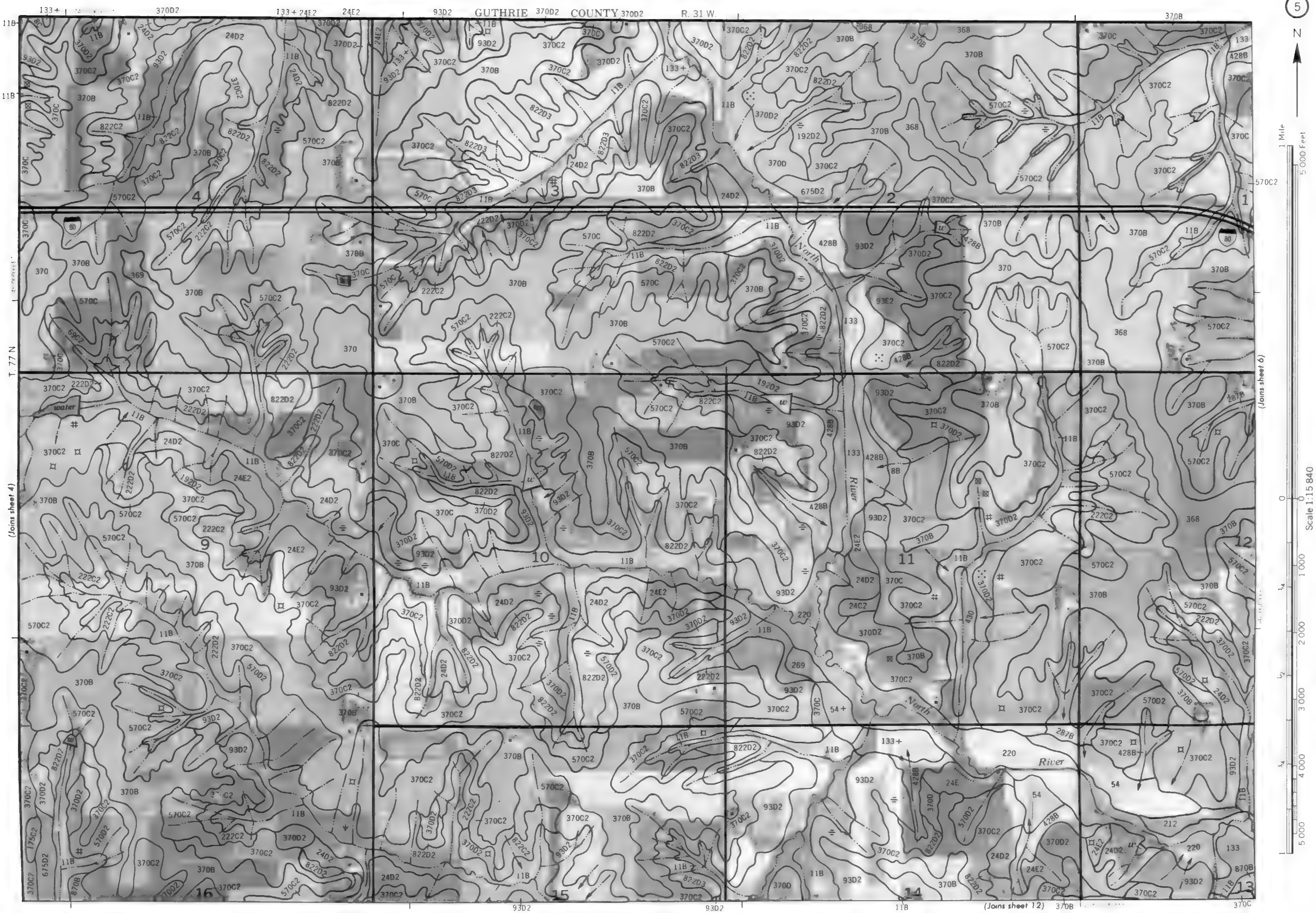


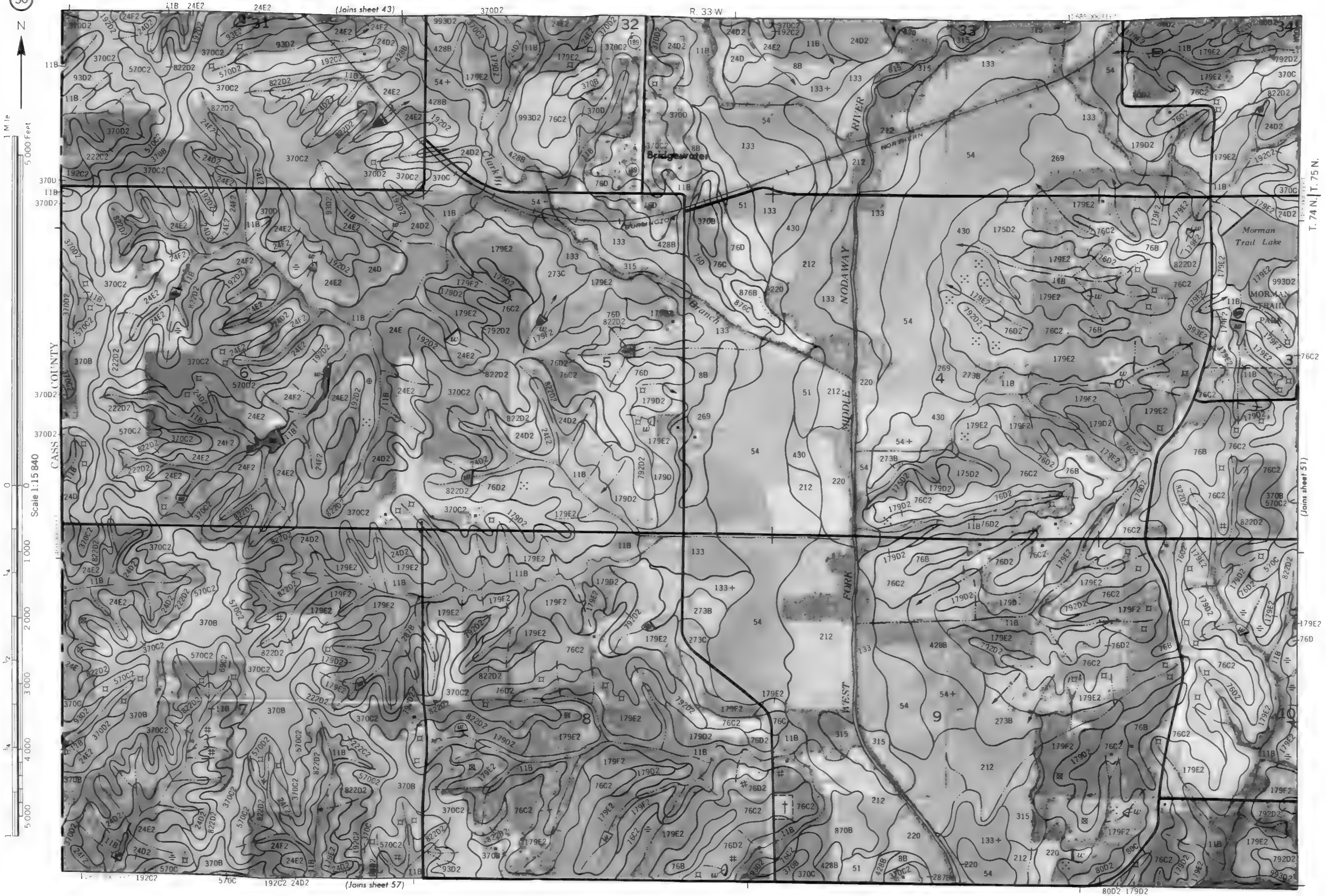

47
N
R 31 W
T 75 N.
(Joins sheet 40)
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 54)
Marvel
Creek
Ninemile
Creek
21
22
23
24
25
26
27
28
33
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4
1


R. 31 W. | R. 30 W.
(Joins sheet 41)
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 55)
T. 75 N.
N
1 Mile
5 000 Feet
Scale 1:15 840
19
20
21
24
25
28
29
30
31
32
33
36
water

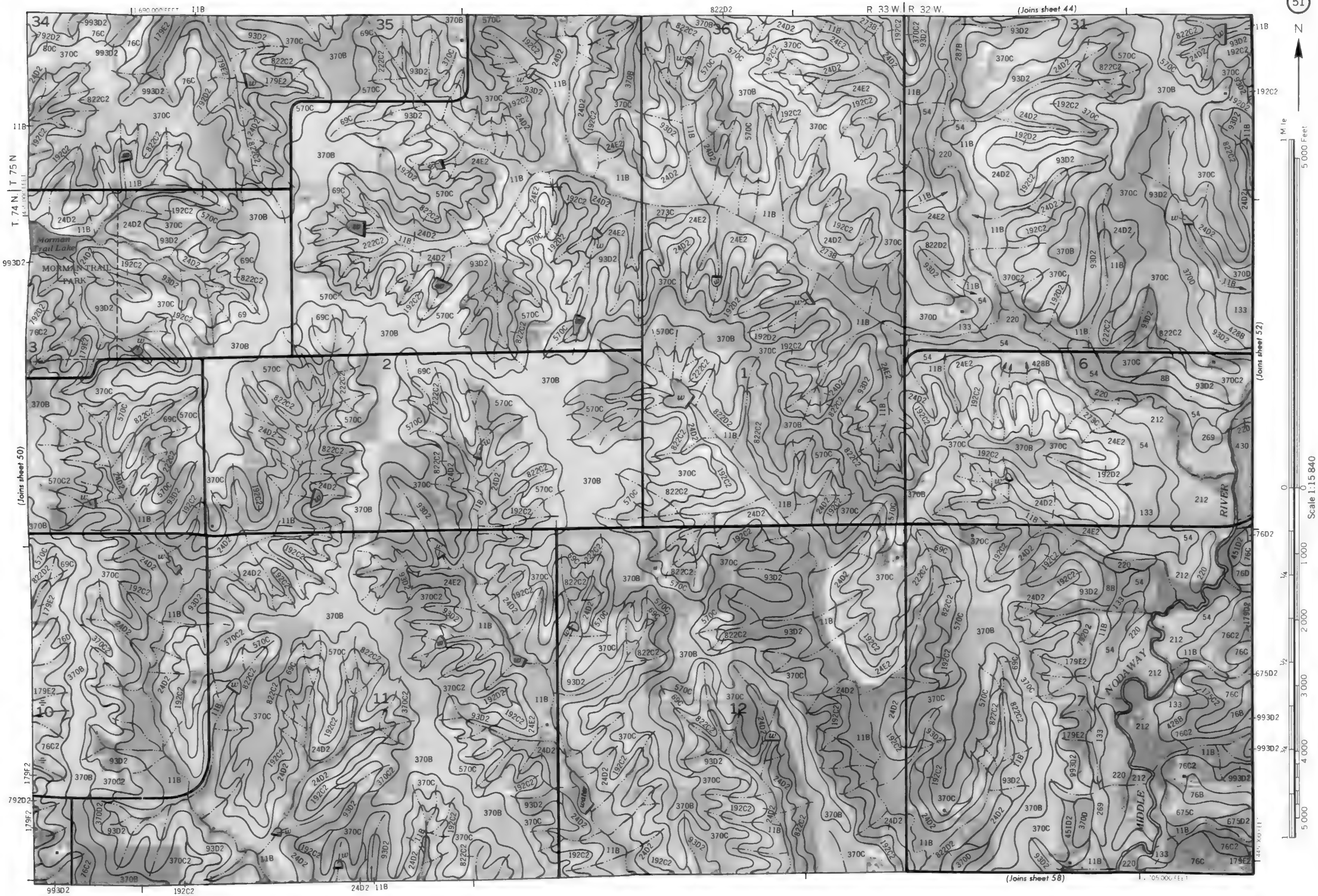


49
N
R. 30 W.
(Joins sheet 42)
(Joins sheet 48)
11B (Joins sheet 56)
T. 75 N.
MADISON COUNTY
Thompson
River
water
22
23
24
25
26
27
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840

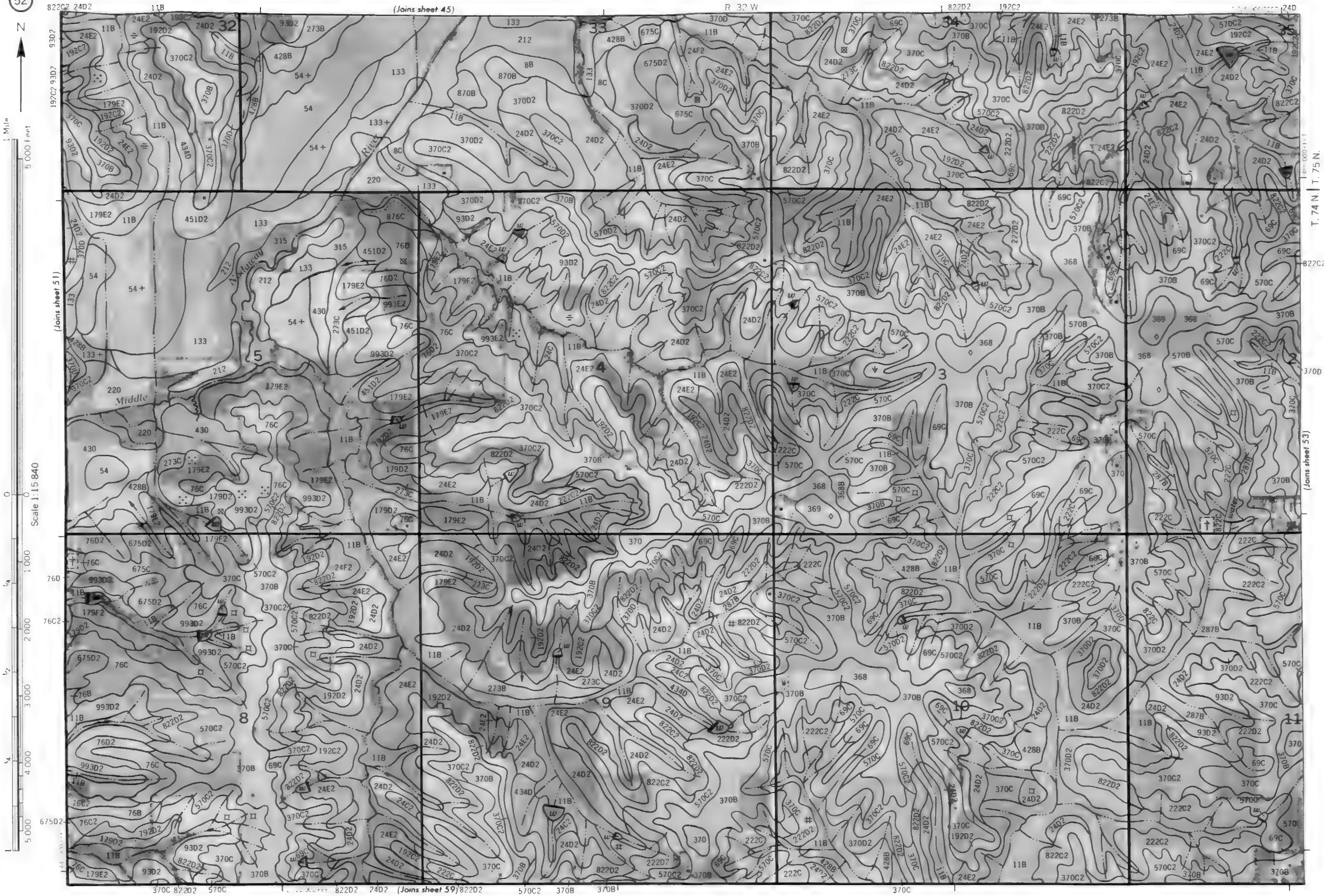

5
N
GUTHRIE COUNTY
R. 31 W.
T. 77 N
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 12)
1 Mile
5 000 Feet
Scale 1:15 840
North River
River
80

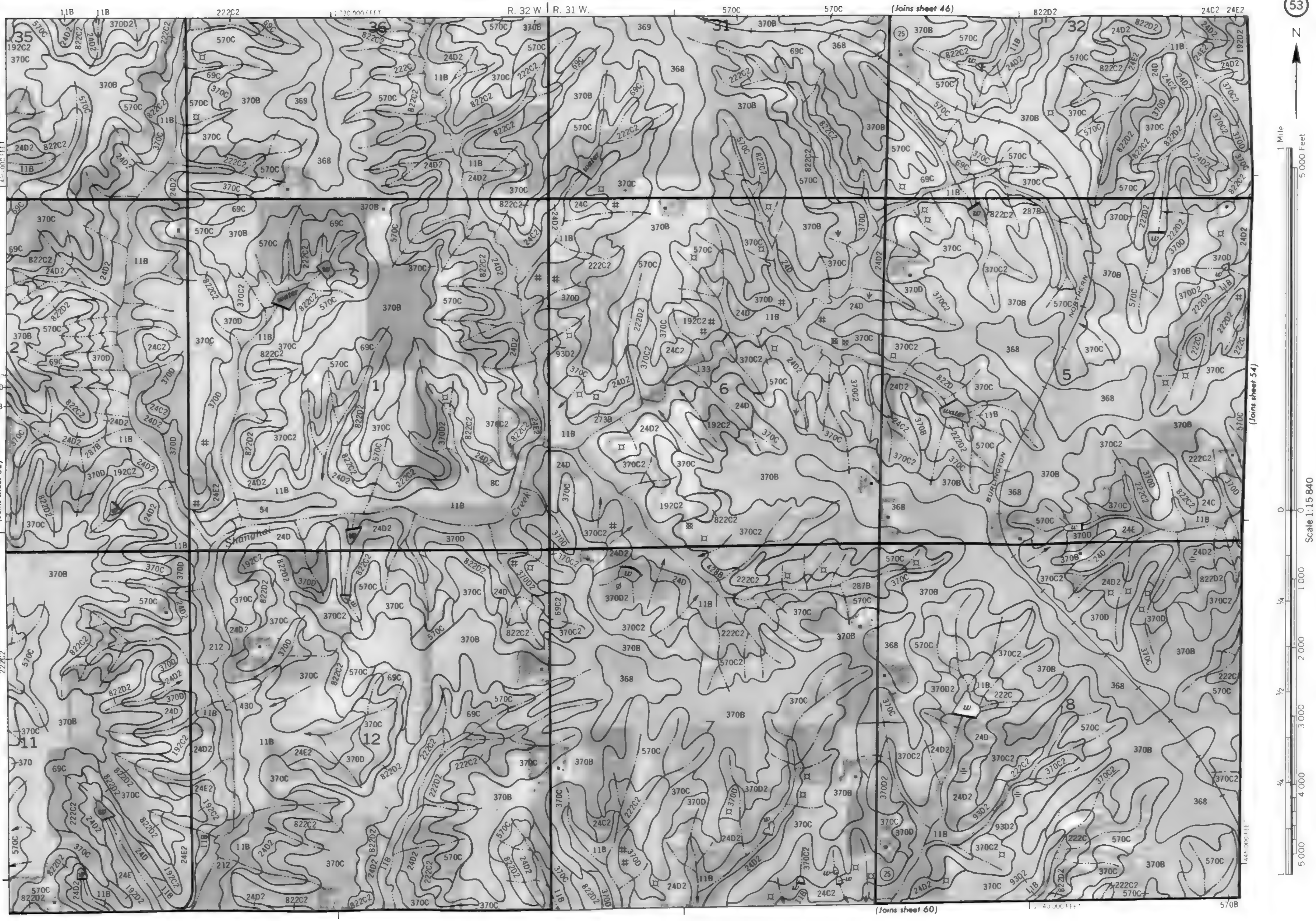

(Joins sheet 43)
R. 33 W.
Bridgewater
NORTHERN
BURLINGTON
Clark
Branch
NODAWAY RIVER
MIDDLE FORK
WEST FORK
Morman Trail Lake
MORMAN TRAIL PARK
T. 74 N. | T. 75 N.
(Joins sheet 51)
(Joins sheet 57)
CASS COUNTY
N
1 Mile
5 000 Feet
Scale 1:15 840
31
32
33
34
6
5
4
3
7
8
9
10

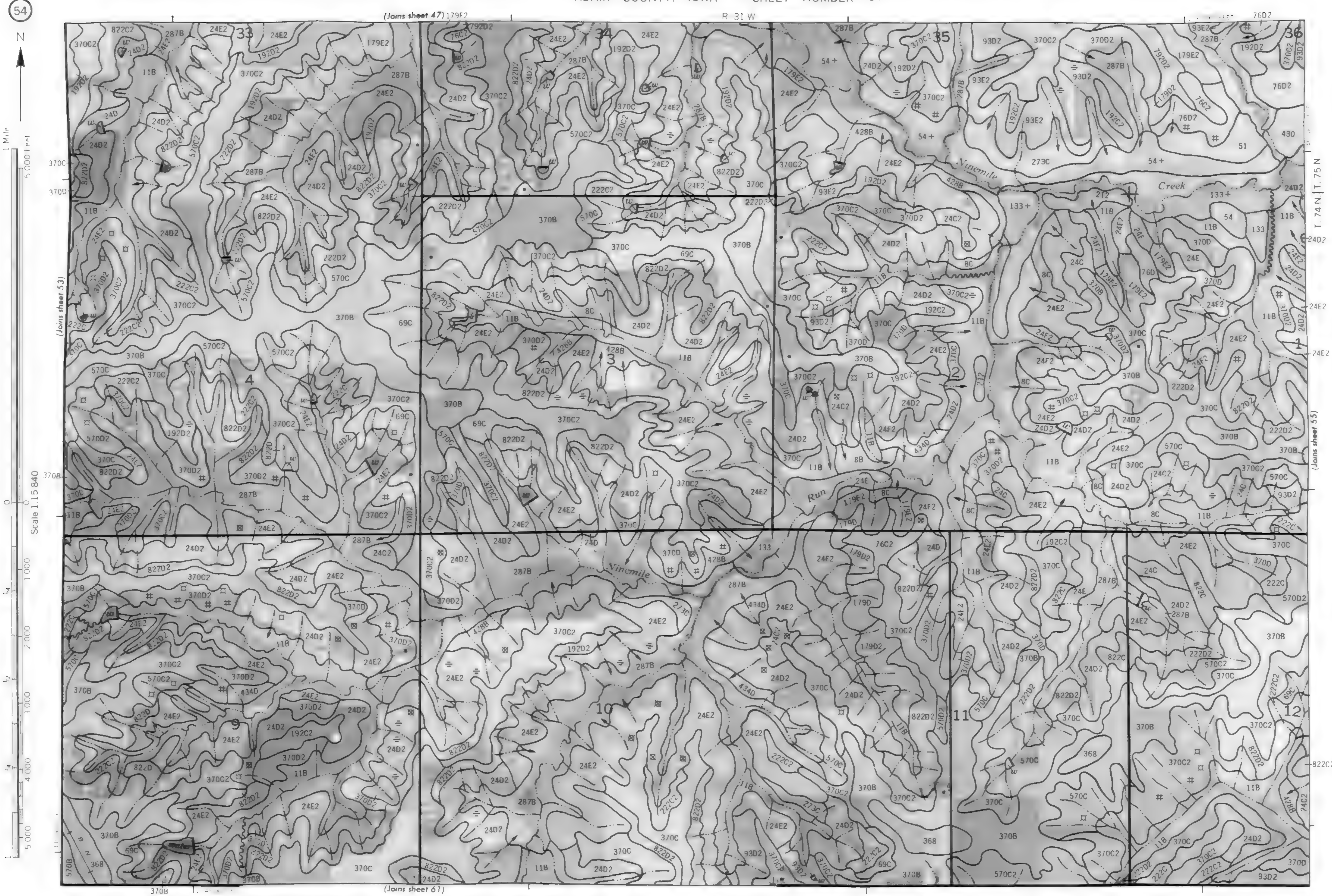
ADAIR COUNTY, IOWA — SHEET NUMBER 51

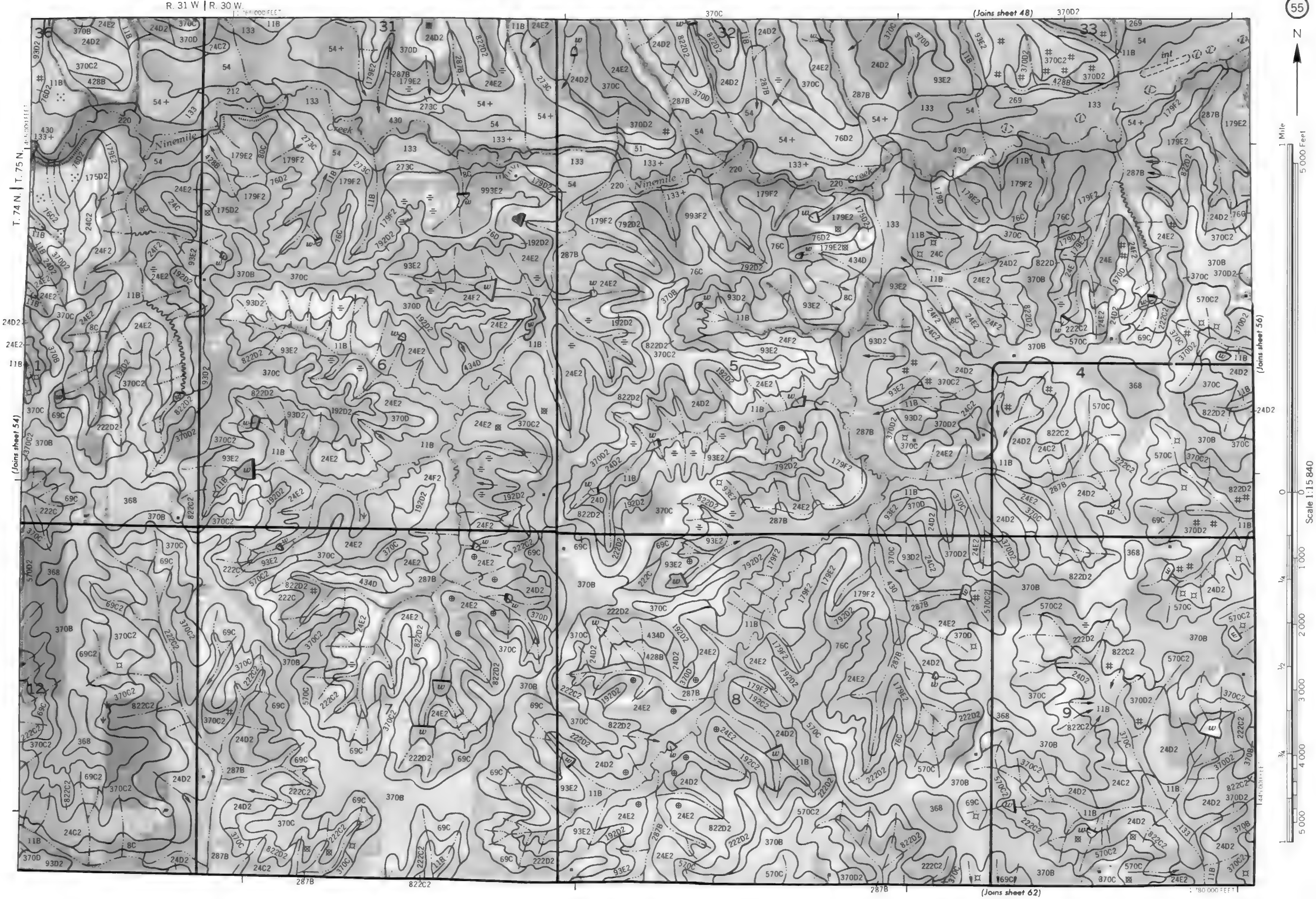


ADAIR COUNTY, IOWA — SHEET NUMBER 52




53
N
(Joins sheet 46)
(Joins sheet 52)
(Joins sheet 54)
(Joins sheet 60)
R. 32 W.
R. 31 W.
T. 75 N.
T. 74 N.
35
36
31
32
2
1
6
5
11
12
8
Shanghai Creek
BURLINGTON NORTHERN
water
1 Mile
5 000 Feet
Scale 1:15 840

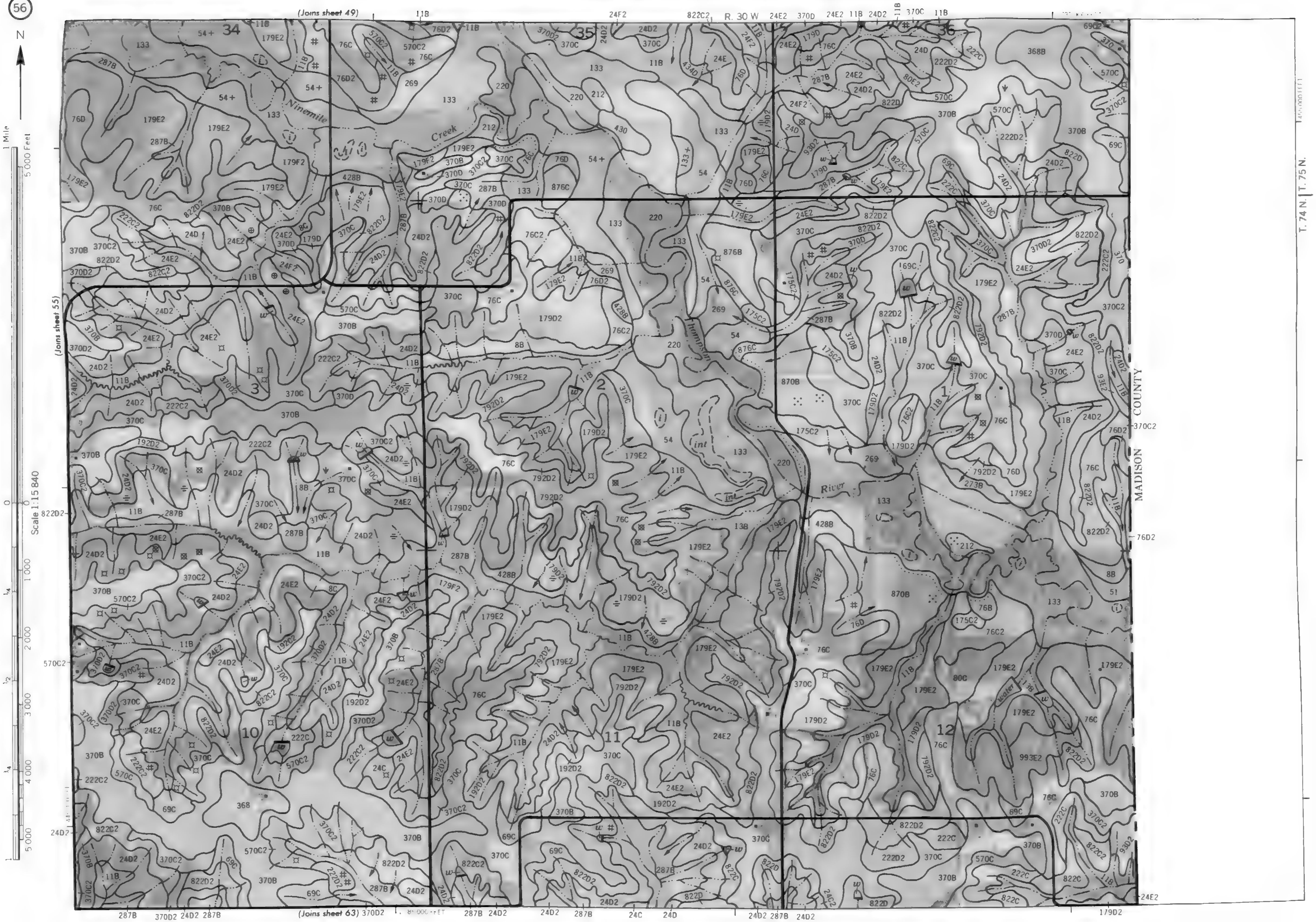

54
N
(Joins sheet 47)
R. 31 W.
T. 74 N.
T. 75 N.
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 61)
Vinemile Creek
Vinemile
Run
33
34
35
36
1
2
3
4
9
10
11
12
1 Mile
5 000 Feet
Scale 1:15 840

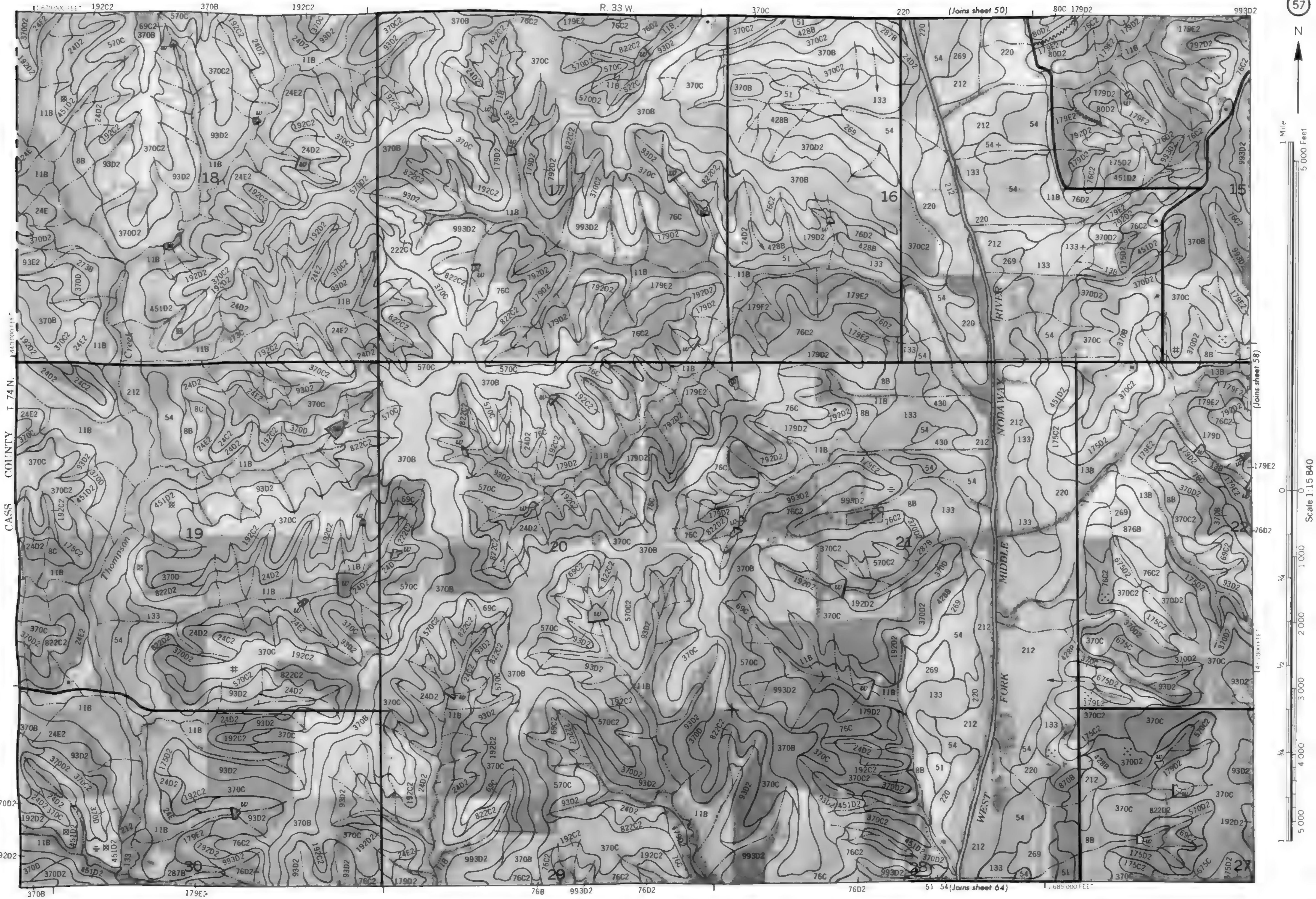


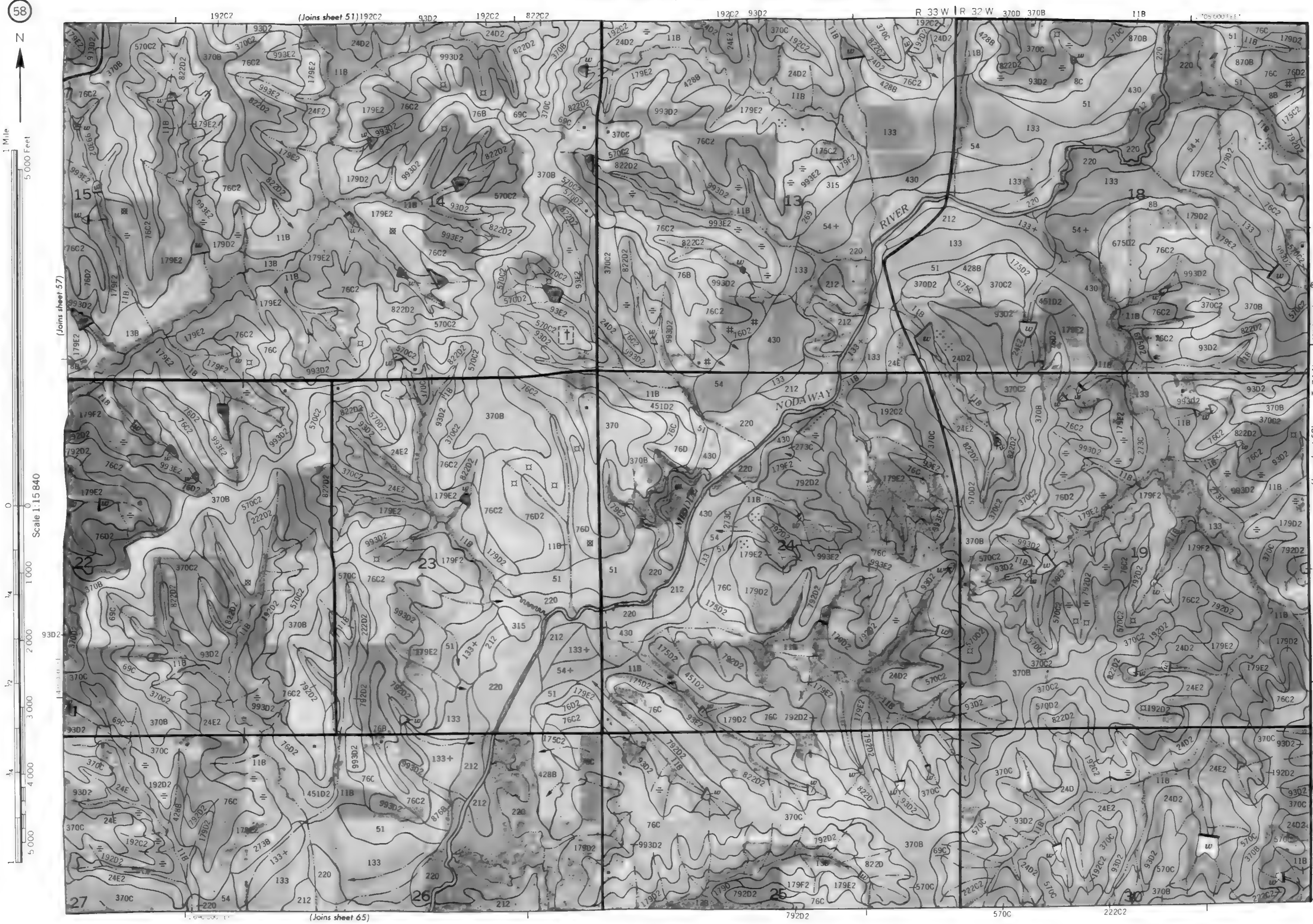
55
N
R. 31 W. | R. 30 W.
T. 74 N. | T. 75 N.
(Joins sheet 48)
(Joins sheet 54)
(Joins sheet 56)
(Joins sheet 62)
Ninemile Creek
Ninemile Creek
1 Mile
5 000 Feet
Scale 1:15 840

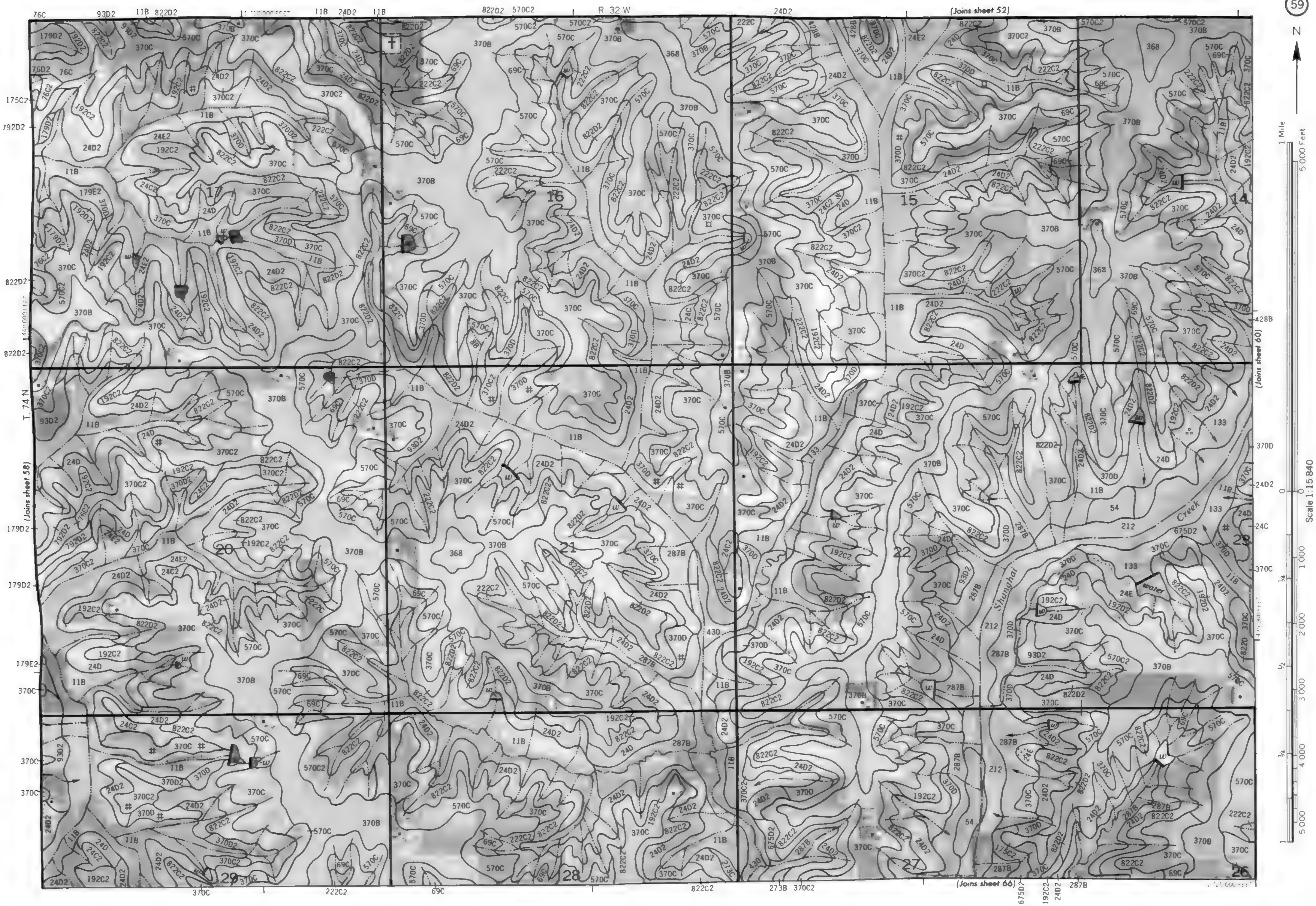
56

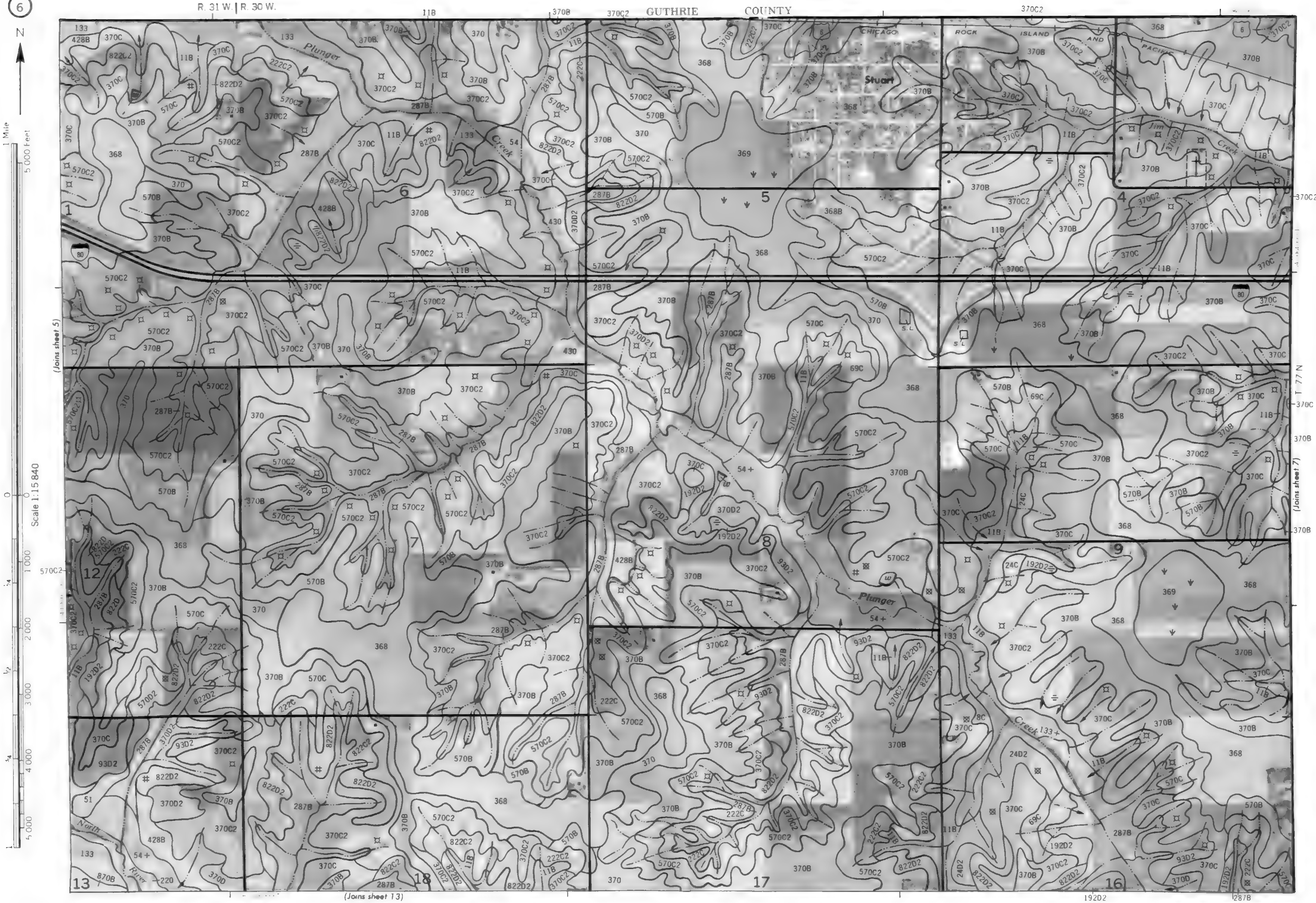
ADAIR COUNTY, IOWA — SHEET NUMBER 56

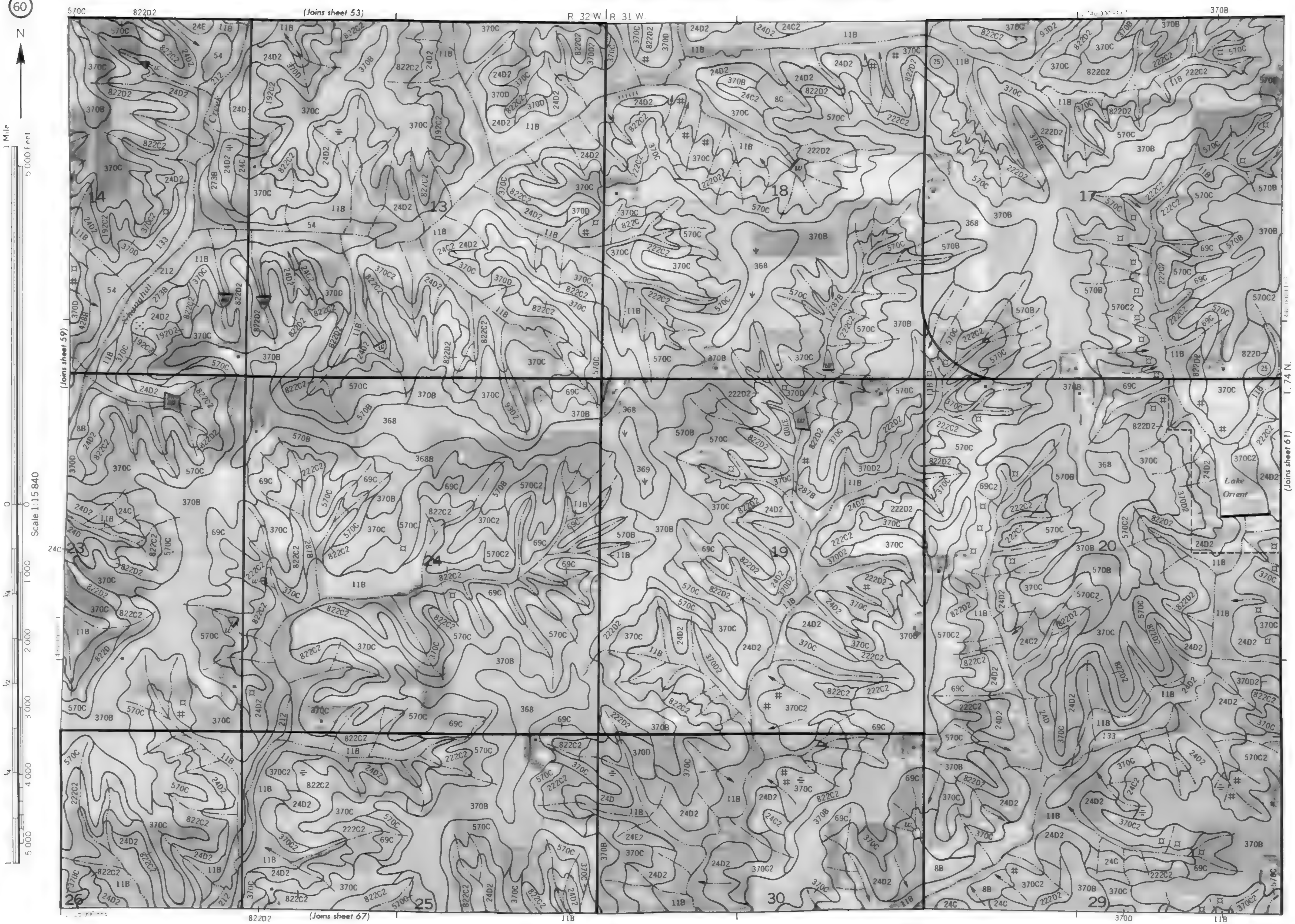


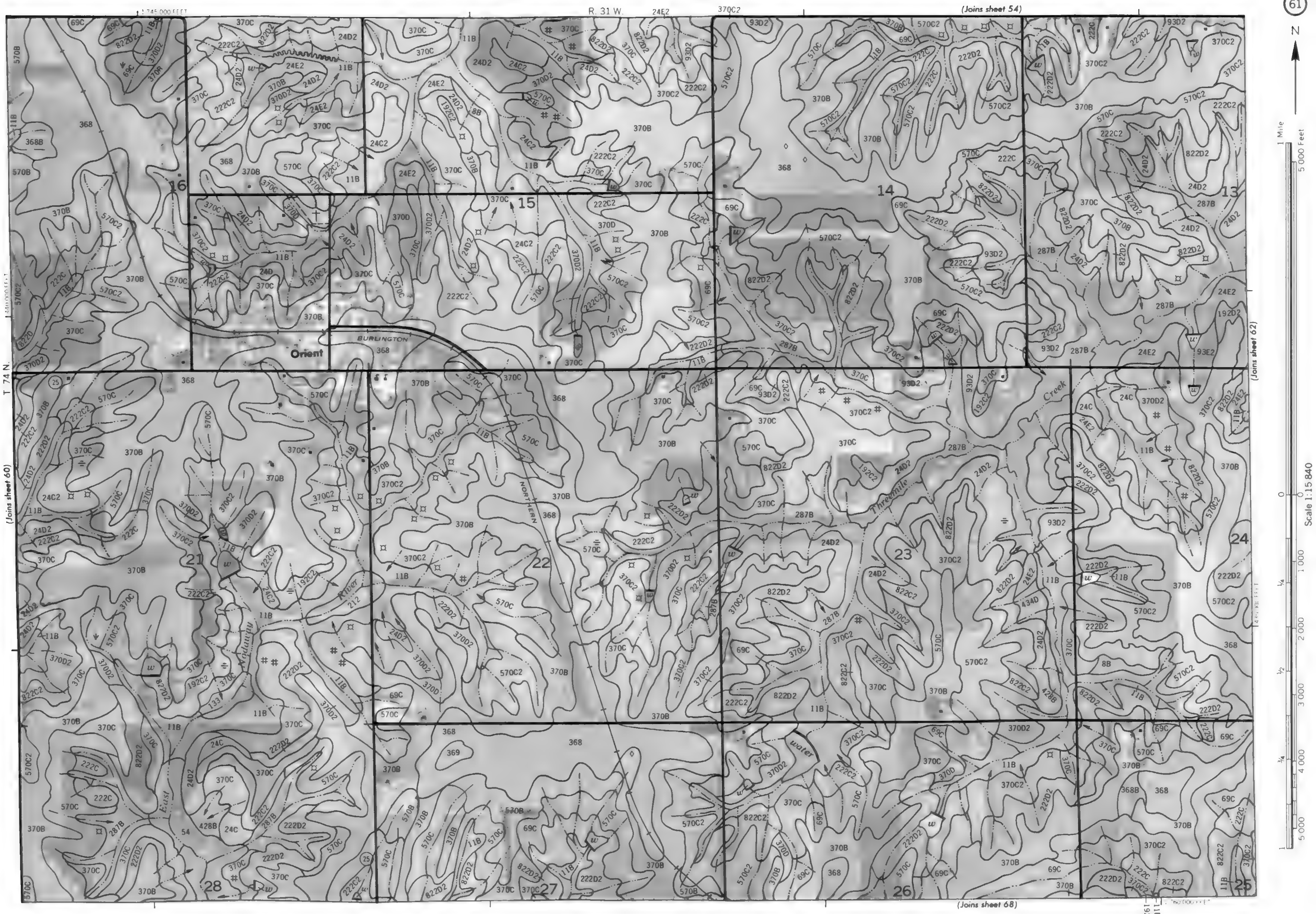

57
N
R. 33 W.
T. 74 N.
CASS COUNTY
(Joins sheet 50)
(Joins sheet 58)
(Joins sheet 64)
Thompson Creek
MIDDLE NODAWAY RIVER
WEST FORK
18
17
16
15
19
20
21
22
30
29
28
27
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1

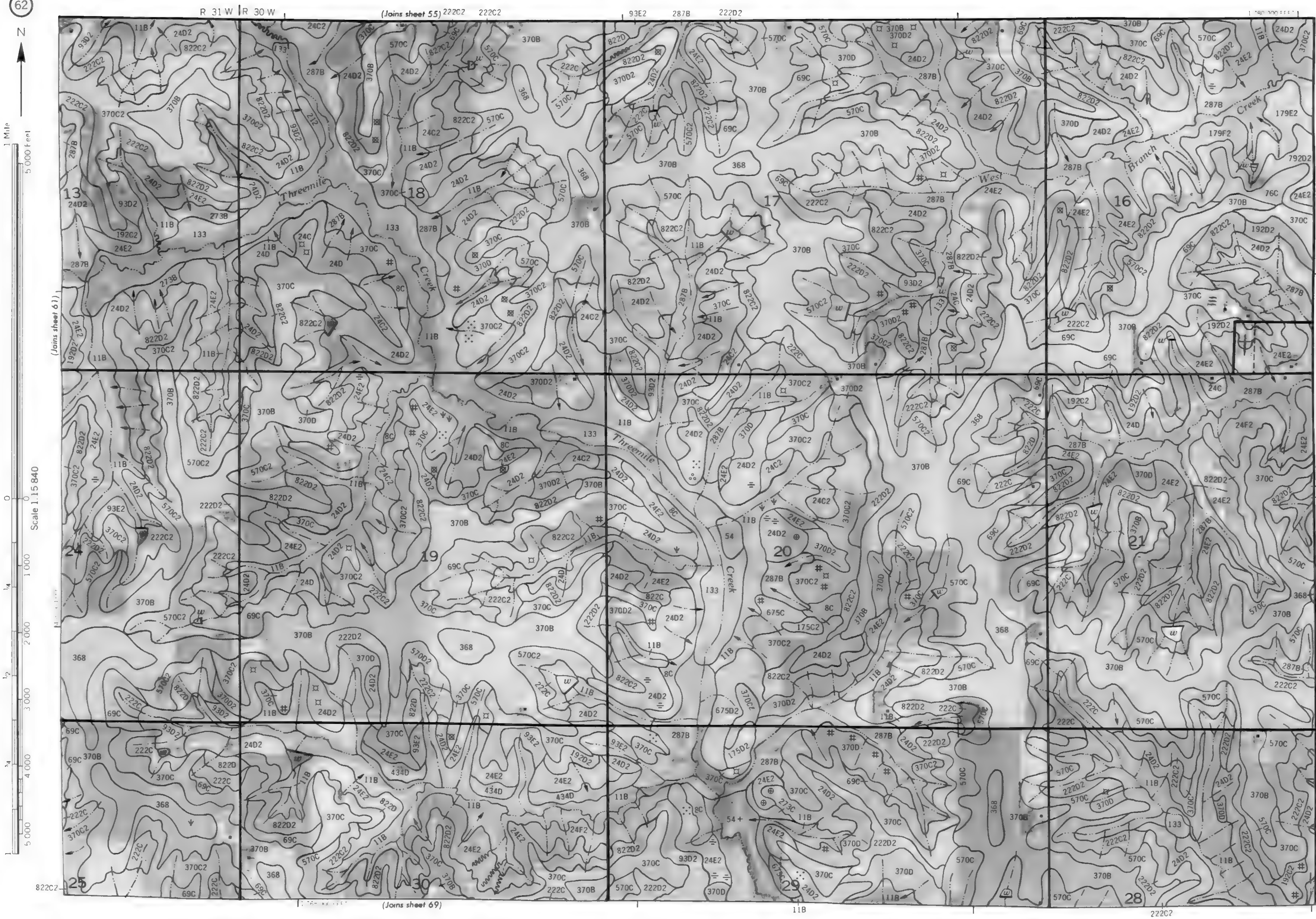

58
N
Scale 1:15 840
(Joins sheet 51)
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 65)
R 33 W
R 32 W
T. 74 N.
NODAWAY
RIVER

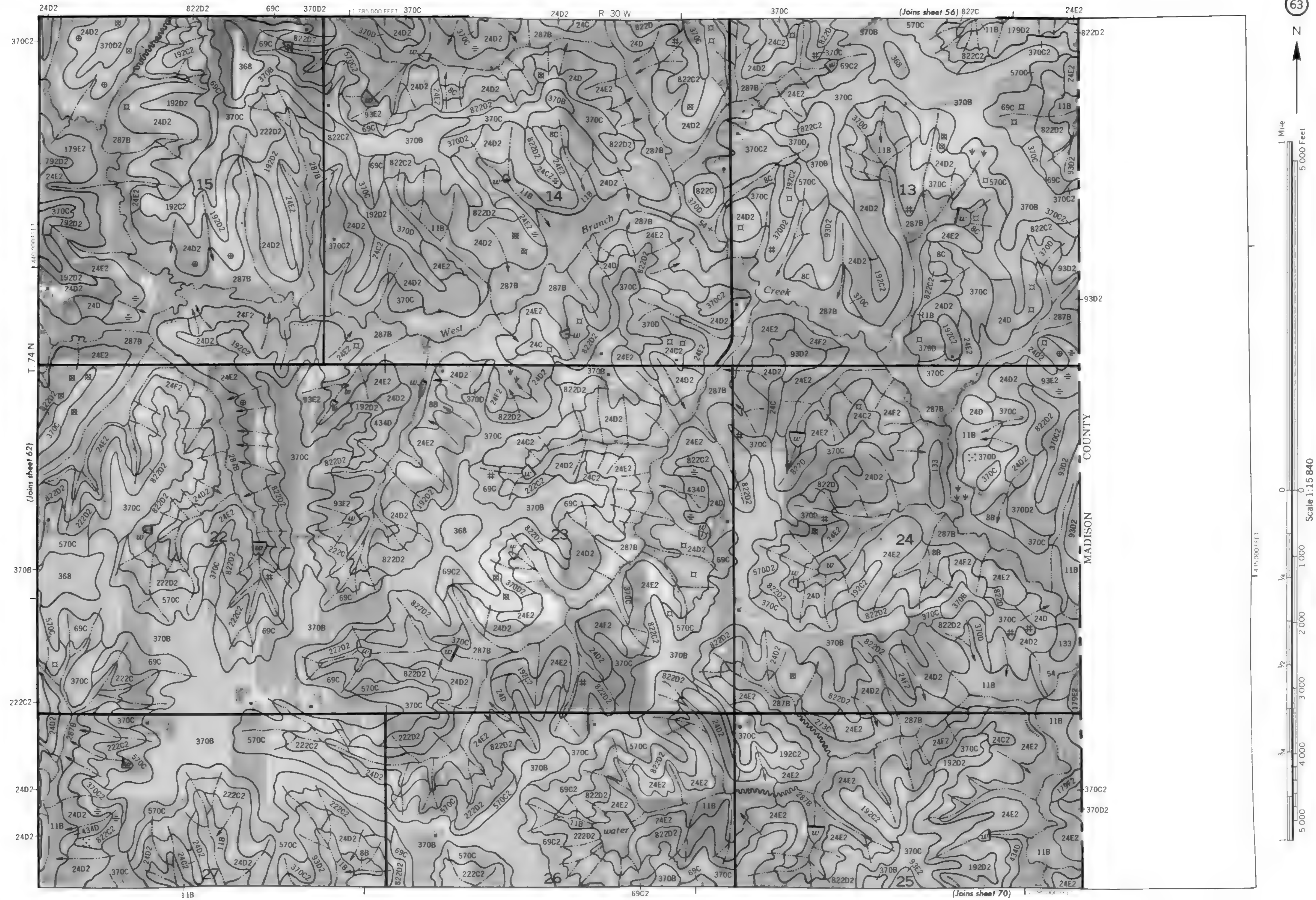

59
R 32 W
(Joins sheet 52)
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 66)
T. 74 N.
17
16
15
14
20
21
22
23
29
28
27
26
Shanghai Creek
N
1 Mile
5 000 Feet
Scale 1:15 840


6
R. 31 W. | R. 30 W.
GUTHRIE COUNTY
N
CHICAGO ROCK ISLAND AND PACIFIC
Stuart
Plunger Creek
Jim Creek
Creek
North River
80
6
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 13)
T. 77 N.
1 Mile
5 000 Feet
Scale 1:15 840
1
4
5
6
7
8
9
12
13
16
17
18


(Joins sheet 53)
R. 32 W. | R. 31 W.
(Joins sheet 59)
(Joins sheet 61)
T. 74 N.
(Joins sheet 67)
N
1 Mile
5 000 Feet
Scale 1:15 840
Lake Orient
Creek
14
13
18
17
23
24
19
20
26
25
30
29

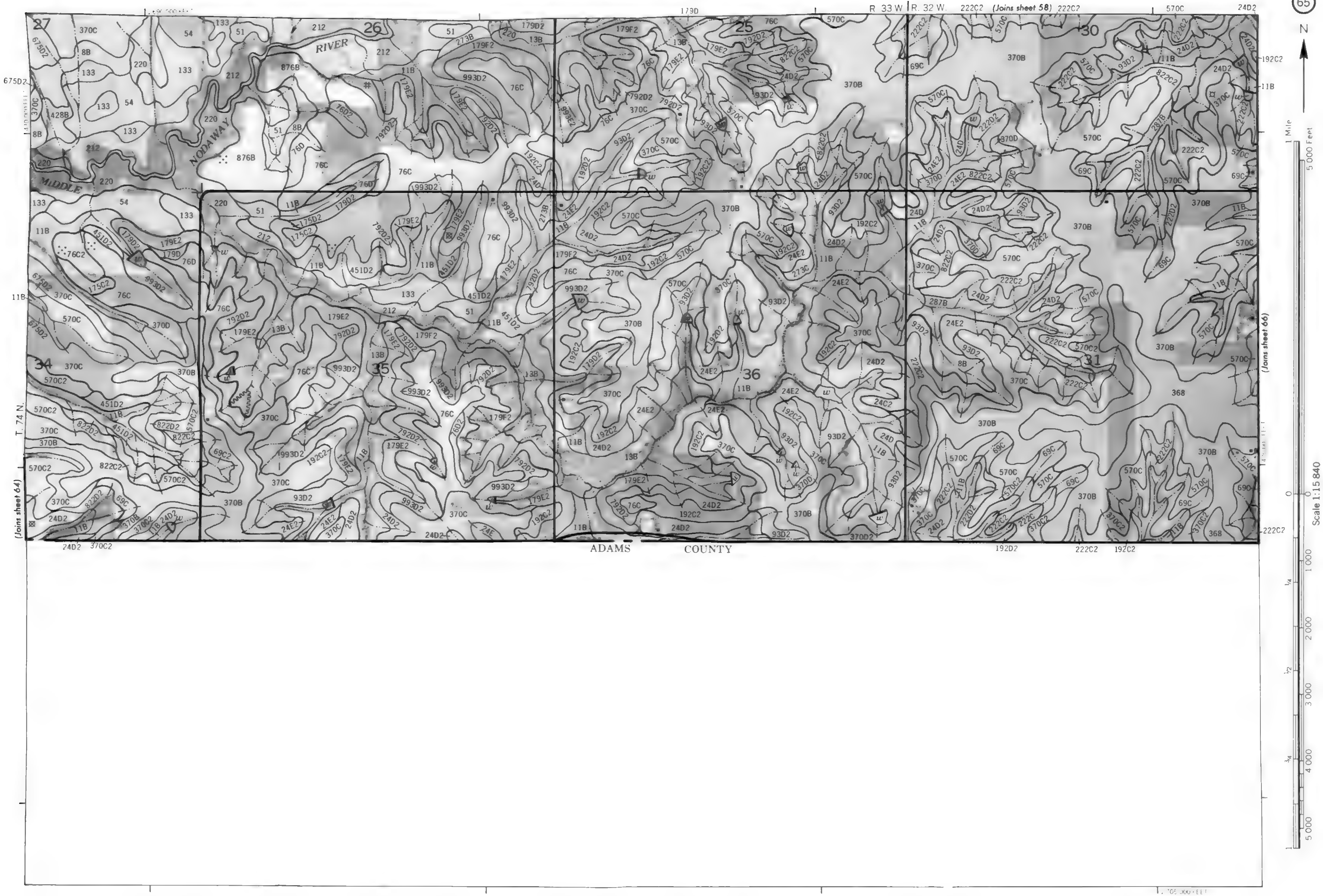

61
N
R. 31 W.
T. 74 N.
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 60)
Orient
BURLINGTON
NORTHERN
Middle River
Threemile Creek
East Nodaway
water
16
15
14
13
21
22
23
24
28
27
26
25
1 Mile
5 000 Feet
Scale 1:15 840

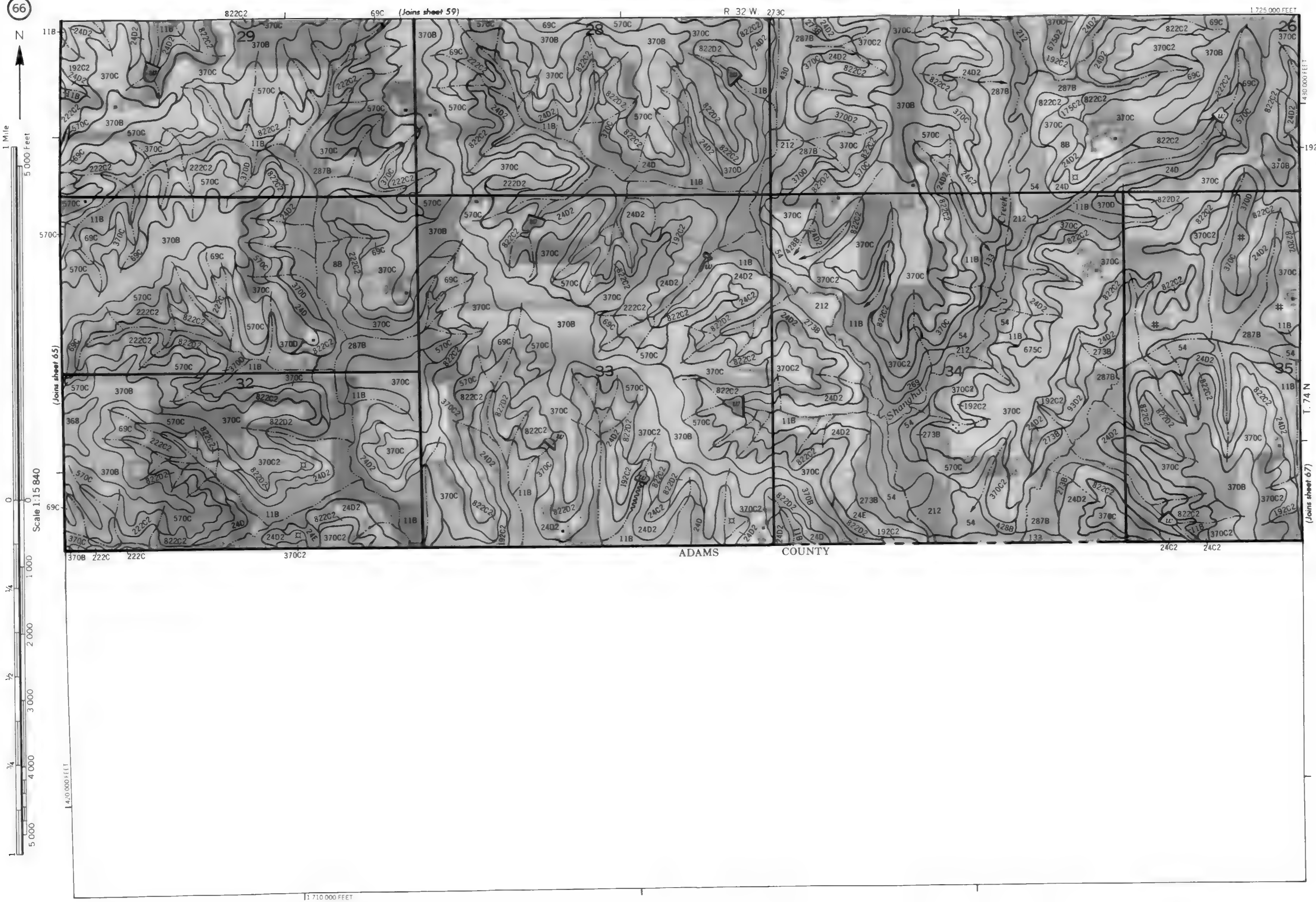

62
N
R. 31 W. | R. 30 W.
(Joins sheet 55)
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 69)
T. 74 N.
Threemile
Creek
West
Branch
Creek
13
18
17
16
24
19
20
21
25
30
29
28
1 Mile
5 000 Feet
Scale 1:15 840


63
N
(Joins sheet 56)
(Joins sheet 62)
(Joins sheet 70)
R 30 W
T. 74 N
1 785 000 FEET
MADISON COUNTY
West
Branch
Creek
water
15
14
13
22
23
24
27
26
25
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000

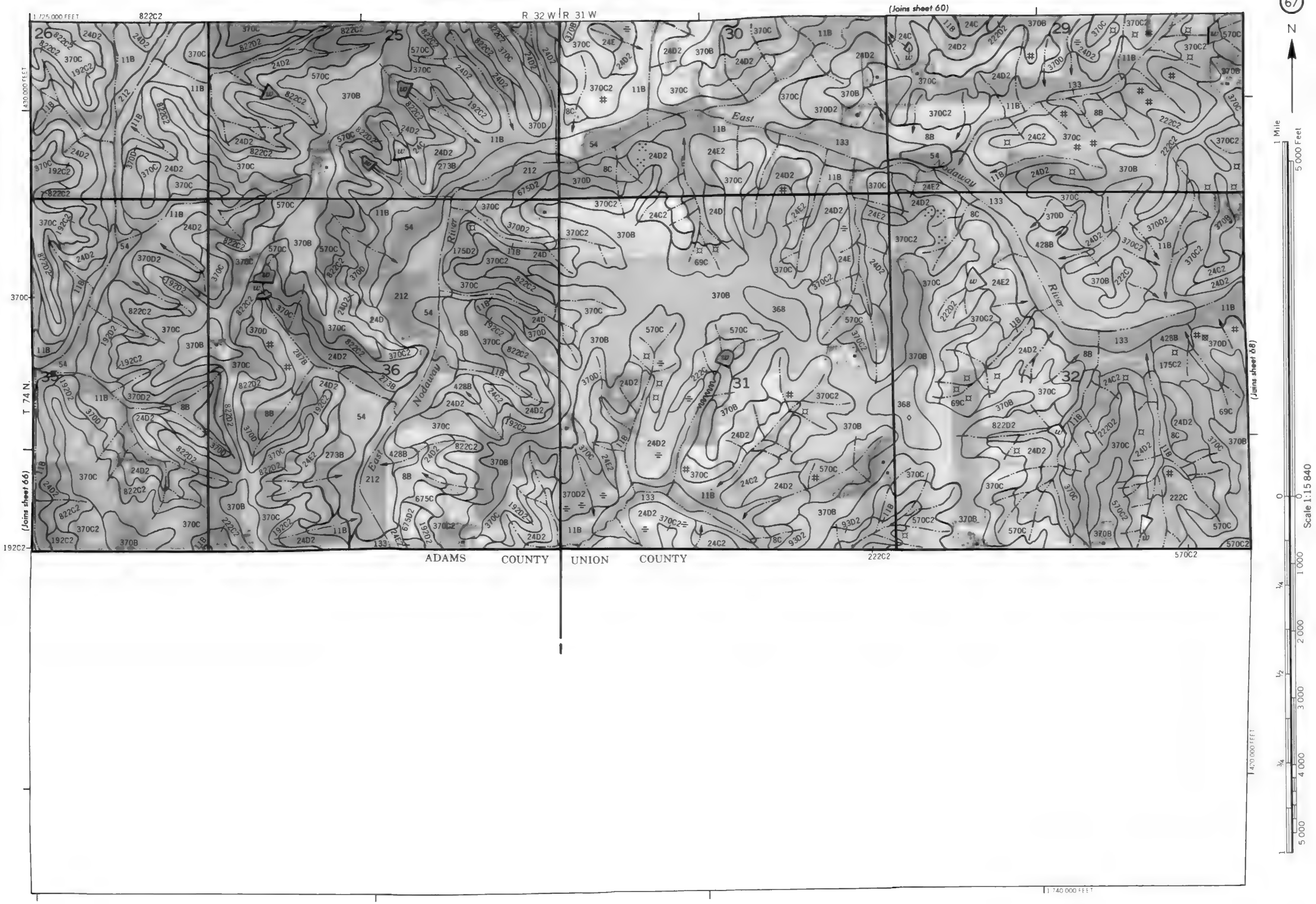
64

ADAIR COUNTY, IOWA — SHEET NUMBER 64

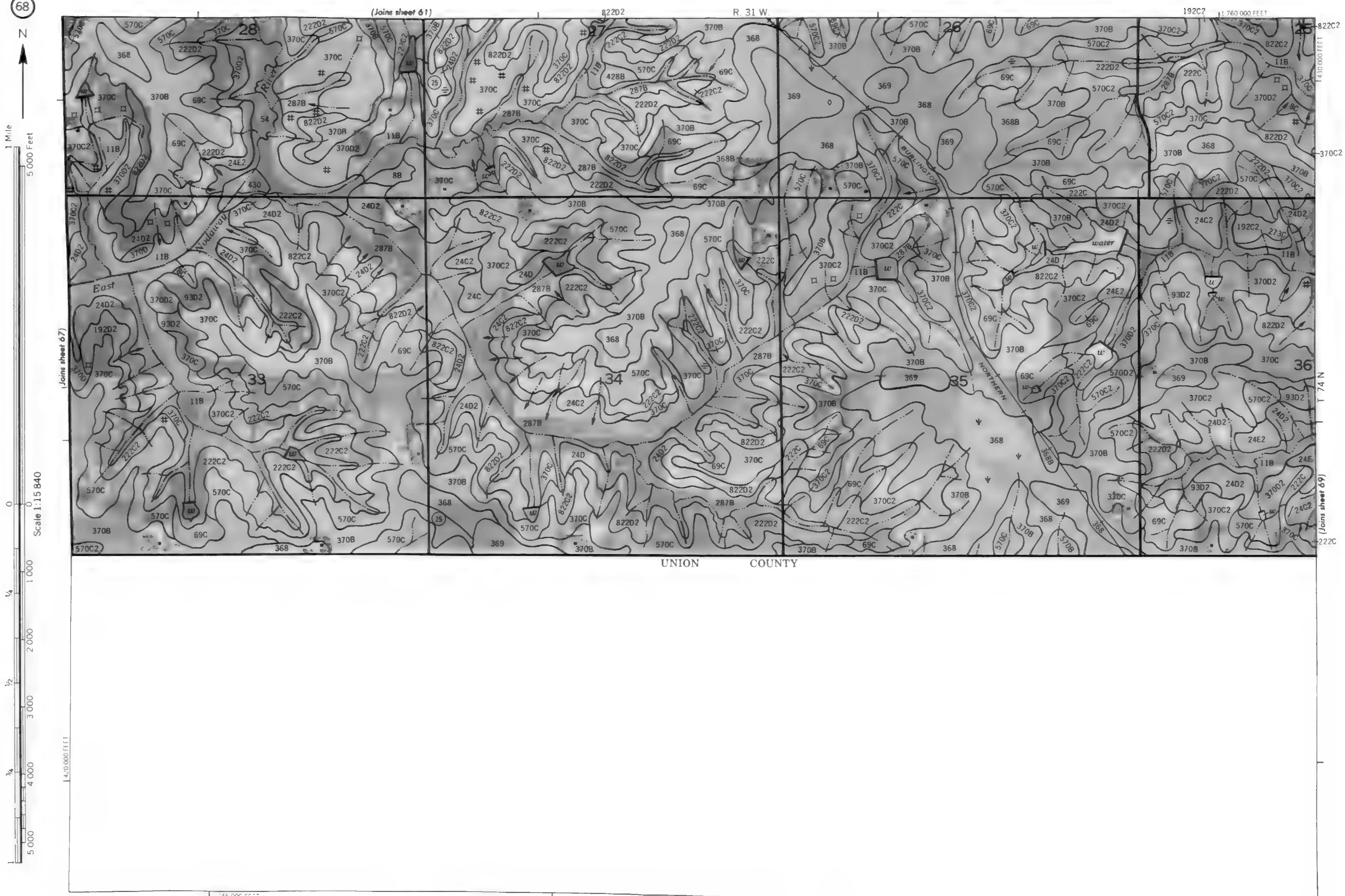

65
N
R. 33 W.
R. 32 W.
(Joins sheet 58)
(Joins sheet 64)
(Joins sheet 66)
T. 74 N.
27
26
25
30
34
35
36
31
MIDDLE
NODAWAY
RIVER
ADAMS
COUNTY
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
0
1/4
1/2
3/4
1

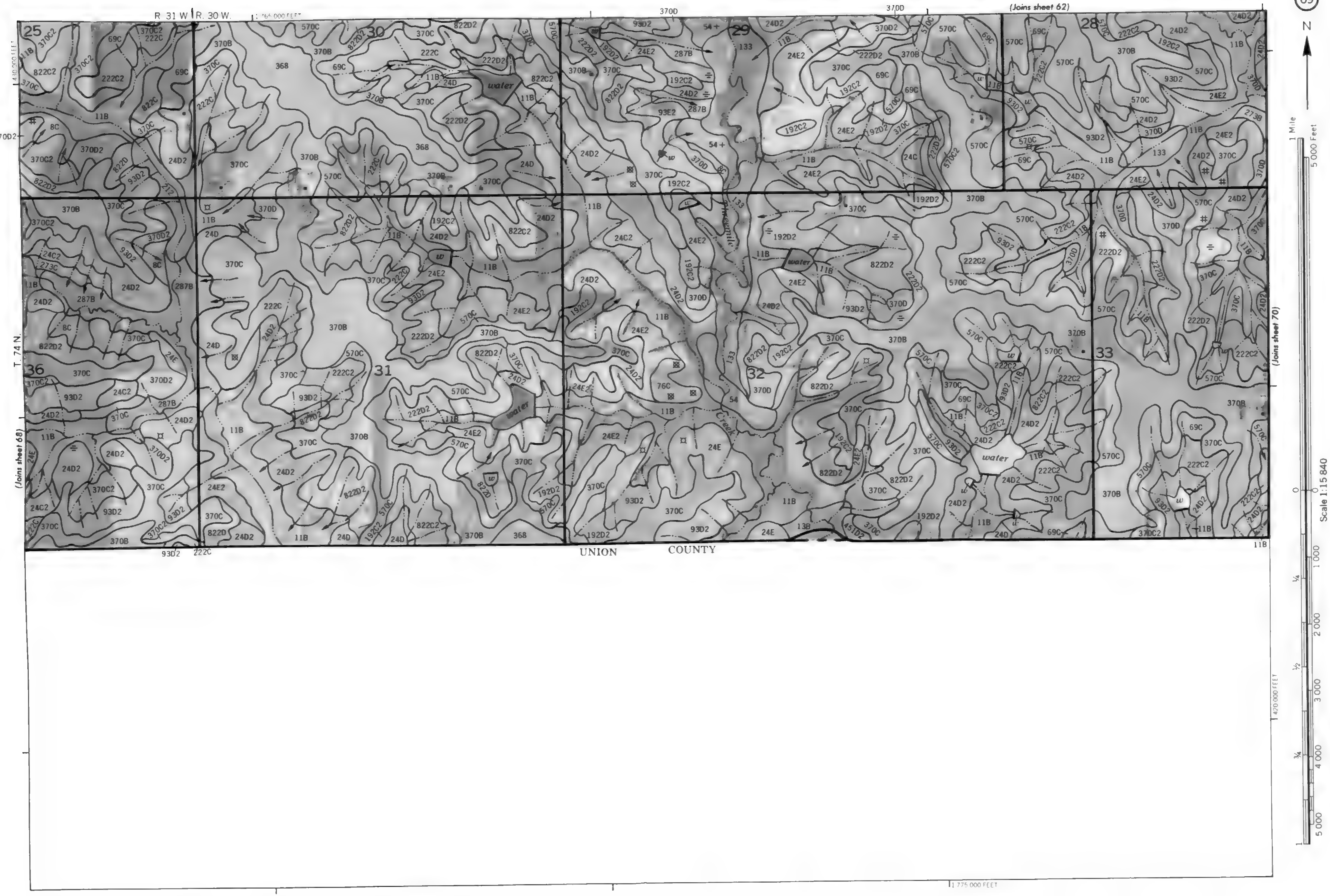

66
N
(Joins sheet 59)
R 32 W.
1 725 000 FEET
430 000 FEET
29
28
27
26
32
33
34
35
(Joins sheet 65)
(Joins sheet 67)
T. 74 N
Shanghai
Creek
ADAMS
COUNTY
1 Mile
5 000 Feet
Scale 1:15 840
420 000 FEET
1 710 000 FEET

ADAIR COUNTY, IOWA — SHEET NUMBER 67

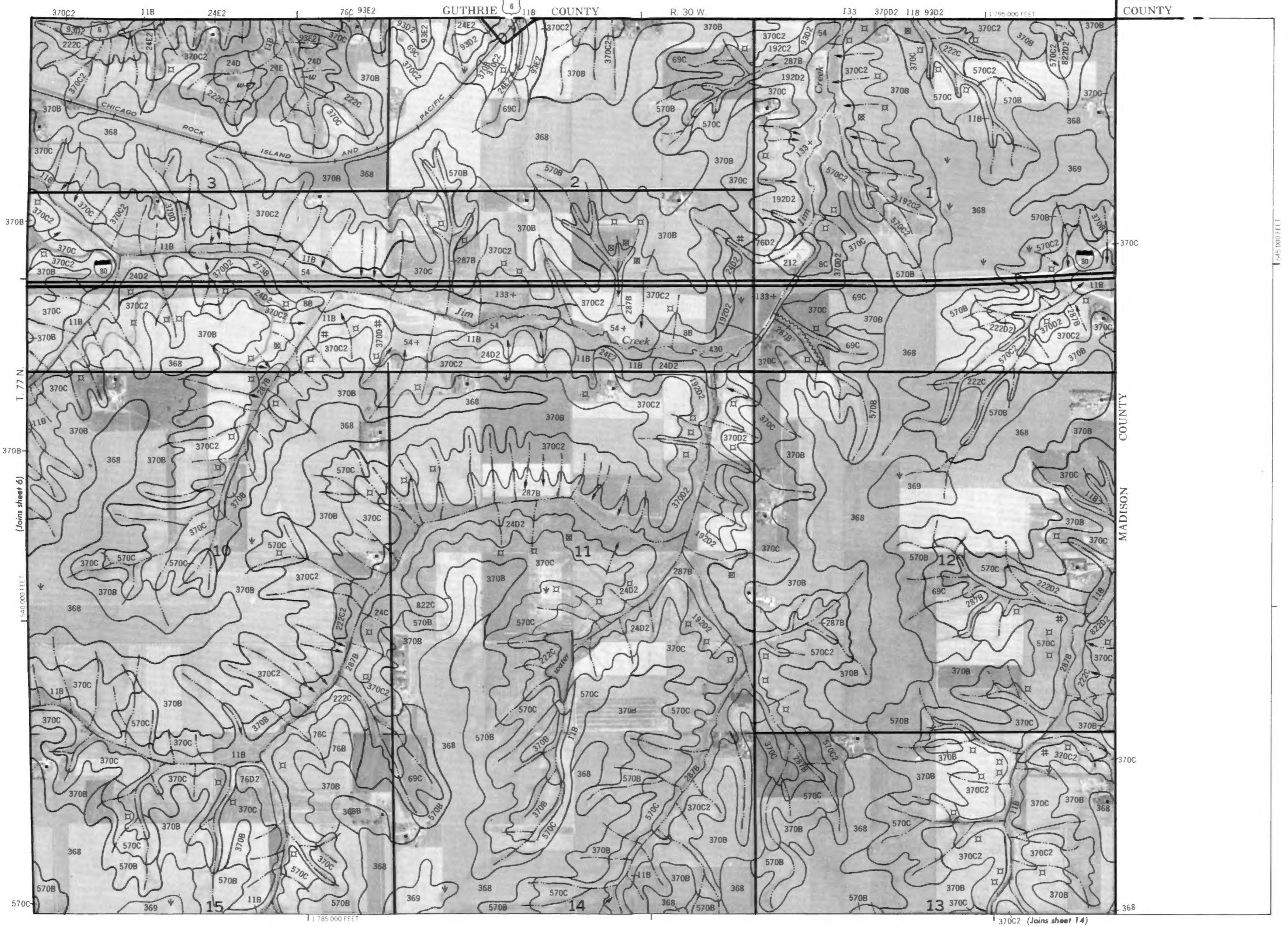


ADAIR COUNTY, IOWA — SHEET NUMBER 68

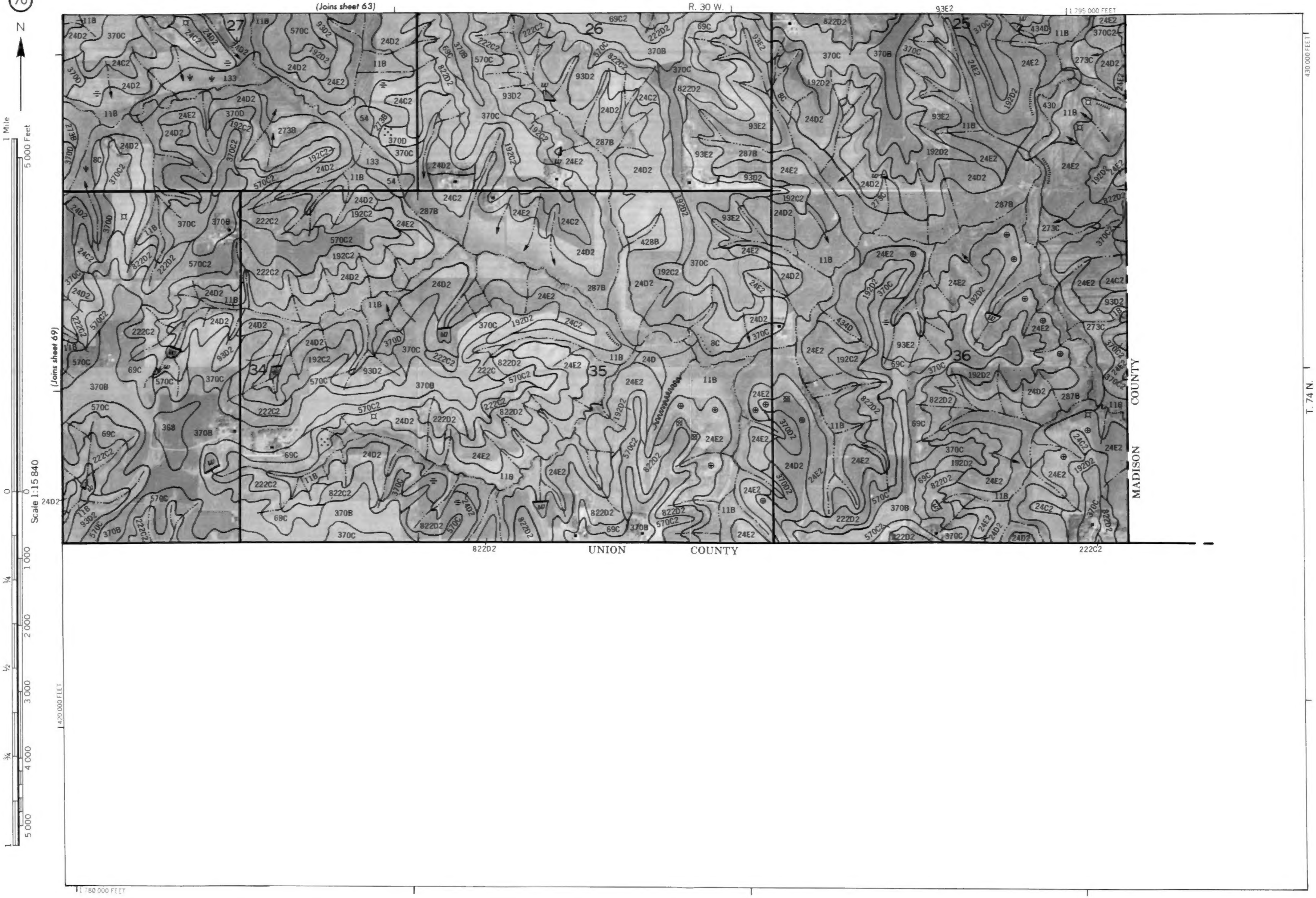


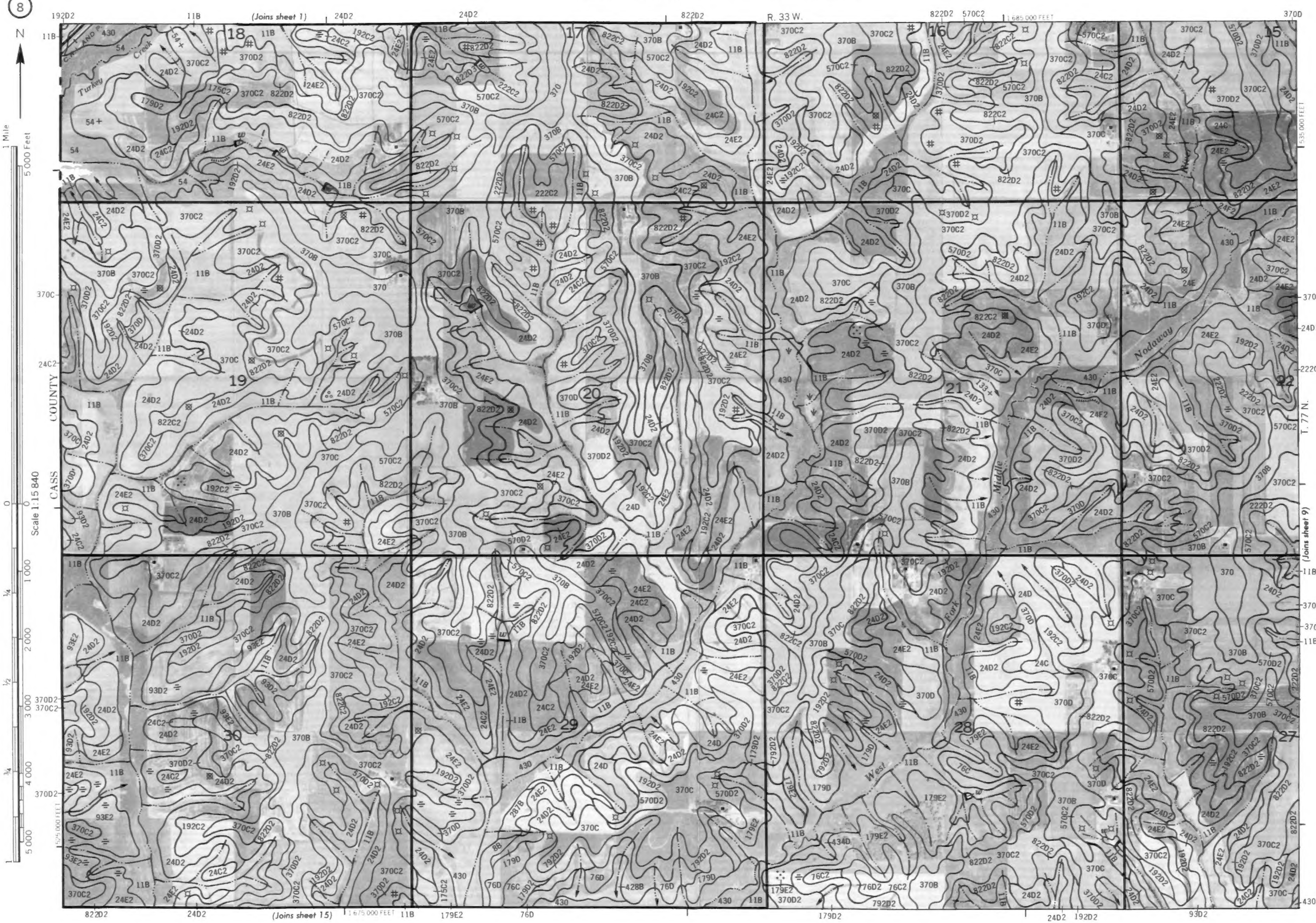

R. 31 W.
R. 30 W.
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 70)
T. 74 N.
25
30
29
28
36
31
32
33
water
Creek
UNION
COUNTY
N
1 Mile
5 000 Feet
Scale 1:15 840

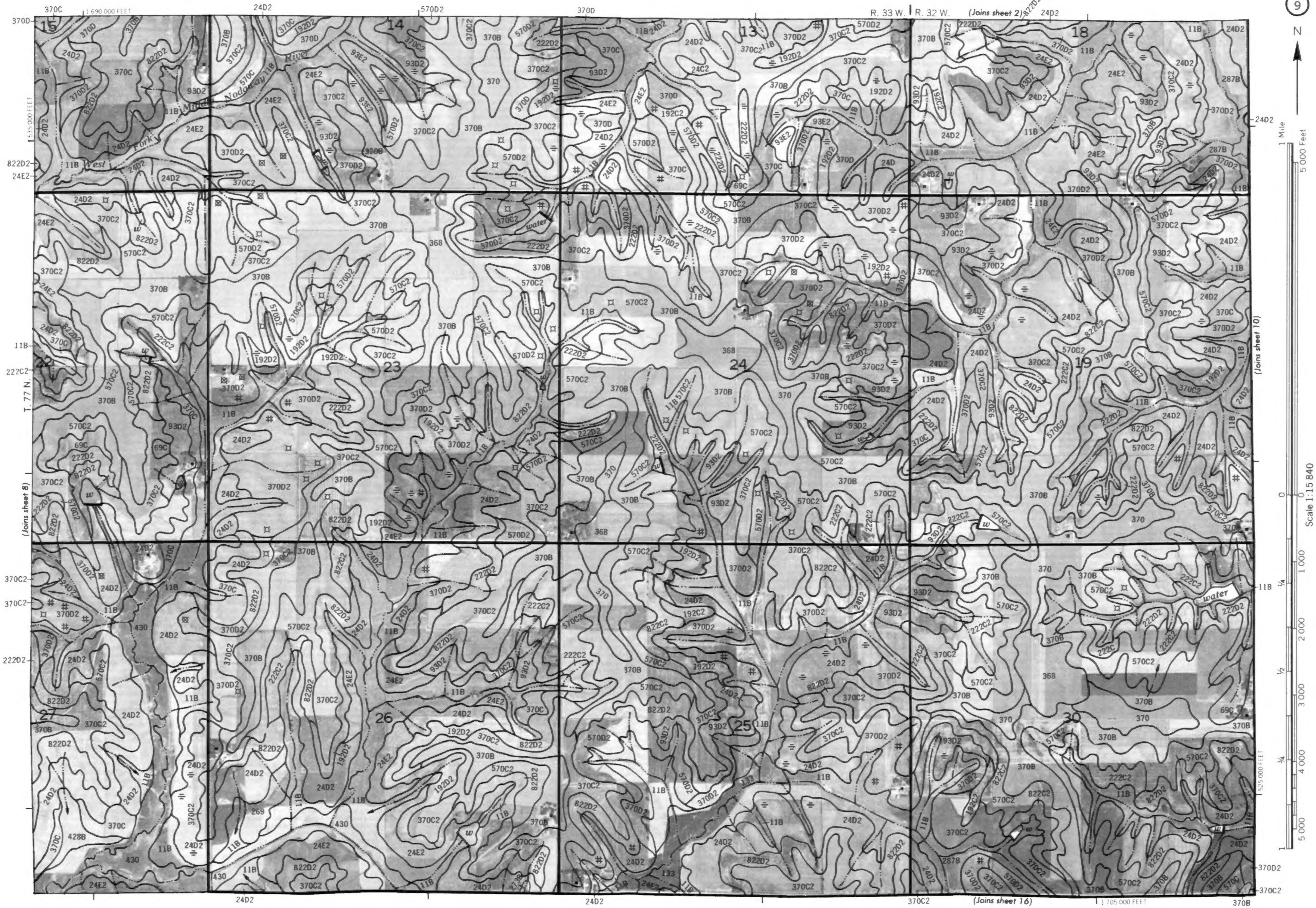
ADAIR COUNTY, IOWA — SHEET NUMBER 7



ADAIR COUNTY, IOWA — SHEET NUMBER 70




(Joins sheet 1)
R. 33 W.
1 685 000 FEET
N
1 Mile
5 000 Feet
Scale 1:15 840
CASS COUNTY
535 000 FEET
T. 77 N.
(Joins sheet 9)
525 000 FEET
(Joins sheet 15)
1 675 000 FEET
Turkey Creek
Nodaway
Middle Fork
West
18
17
16
15
19
20
21
22
30
29
28
27


9
N
1 690 000 FEET
535 000 FEET
R. 33 W.
R. 32 W.
(Joins sheet 2)
(Joins sheet 10)
(Joins sheet 8)
(Joins sheet 16)
T. 77 N.
1 705 000 FEET
525 000 FEET
Middle Nodaway River
West Fork
water
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000
13
14
15
18
19
22
23
24
25
26
27
30